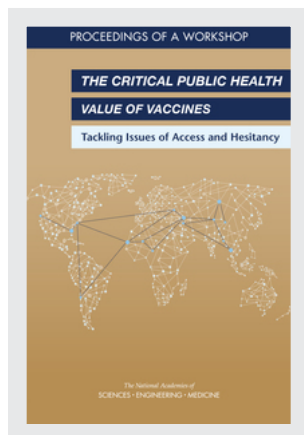


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THE CRITICAL PUBLIC HEALTH VALUE OF VACCINES

Tackling Issues of Access and Hesitancy

PROCEEDINGS OF A WORKSHOP

Julie Liao, Charles Minicucci, and Anna Nicholson, *Rapporteurs*

Forum on Microbial Threats

Board on Global Health

Health and Medicine Division

The National Academies of
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¹ The planning committee's role was limited to planning the workshop, and the Proceedings of a Workshop was prepared by the workshop rapporteurs as a factual summary of what occurred at the workshop. Statements, recommendations, and opinions expressed are those of individual presenters and participants and are not necessarily endorsed or verified by the National Academies of Sciences, Engineering, and Medicine, and they should not be construed as reflecting any group consensus.

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This Proceedings of a Workshop was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published proceedings as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the proceedings nor did they see the final draft before its release. The review of this proceedings was overseen by **GERALD T. KEUSCH**, Boston University. He was responsible for making certain that an independent examination of this proceedings was carried out in accordance with standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the rapporteurs and the National Academies.

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Acronyms and Abbreviations

ACIP	Advisory Committee on Immunization Practices
AFRO	WHO Regional Office for Africa
AMRO	WHO Regional Office for the Americas
APhA	American Pharmacists Association
BeSD	behavioral and social drivers
CDC	U.S. Centers for Disease Control and Prevention
CEPI	Coalition for Epidemic Preparedness Innovations
COVID-19	coronavirus disease 2019
DTP	diphtheria, tetanus, and pertussis vaccine (pediatric)
EPI	Expanded Programme on Immunization (WHO)
FDA	U.S. Food and Drug Administration
GACVS	Global Advisory Committee on Vaccine Safety
HPV	human papillomavirus
IEP	individualized education program
IFRC	International Federation of Red Cross and Red Crescent Societies
IPC	infection prevention and control

LMIC	low- or middle-income country
LSHTM	London School of Hygiene & Tropical Medicine
MCV	measles-containing vaccine
MERS	Middle East respiratory syndrome
MMR	measles, mumps, and rubella
MOH	Ministry of Health
NGO	nongovernmental organization
NIH	National Institutes of Health
NITAG	National Immunization Technical Advisory Group (WHO)
OR	odds ratio
PHE	Public Health England
PIRI	periodic intensification of routine immunization (WHO)
PPE	personal protective equipment
RCT	randomized controlled trial
SAGE	Strategic Advisory Group of Experts on Immunization (WHO)
SARS	severe acute respiratory syndrome
SARS-CoV-2	severe acute respiratory syndrome coronavirus 2
SMS	short message service
TIP	Tailoring Immunization Programmes
UCI	universal child immunization
UNICEF	United Nations Children's Fund
VAERS	Vaccine Adverse Event Reporting System
VSD	Vaccine Safety Datalink
WHO	World Health Organization

1

Introduction

Immunization against disease is among the most successful global health efforts of the modern era, and substantial gains in vaccination coverage rates have been achieved worldwide. However, that progress has stagnated in recent years, leaving an estimated 20 million children worldwide either undervaccinated or completely unvaccinated (UNICEF, 2020). The determinants of vaccination uptake are complex, mutable, and context specific. A primary driver is vaccine hesitancy—defined as a “delay in acceptance or refusal of vaccines despite availability of vaccination services”—which was identified by the World Health Organization (WHO) as one of the top 10 threats to global health in 2019 (WHO, 2019). While there exists a vocal minority of people who are entirely opposed to vaccination, the majority of vaccine-hesitant people fall somewhere on a spectrum from vaccine acceptance to vaccine denial. Vaccine uptake is also hampered by socioeconomic or structural barriers to access. Targeted approaches are needed to mitigate barriers to accessing routine and pandemic-related vaccination services, build trust between patients and providers to encourage effective communication about vaccines, and dispel the myths and misinformation that erode public confidence in vaccines (CDC NCIRD, 2019).

The Forum on Microbial Threats convenes workshops spanning a range of issues related to infectious diseases, from their economic drivers (NASEM, 2018) to their convergence with noncommunicable diseases (NASEM, 2019a) to the frontiers of innovation to counter microbial threats (NASEM, 2020), including antimicrobial resistance (NASEM, 2017). In 2018, the forum examined the state of national and international readiness for pandemic threats in a workshop that explored lessons

learned a century after the 1918 influenza pandemic, which seems prescient in hindsight (NASEM, 2019b). To tackle the entwined issues of vaccine access and hesitancy, in August 2020 in the midst of the global pandemic of coronavirus disease 2019 (COVID-19), the disease caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the forum convened this second workshop in a series focused on the critical public health value of vaccines and strategies.

The issues of vaccine confidence, access, and uptake have never been more critical or pressing, given that ending the pandemic will likely hinge on the deployment of a safe and effective vaccine on an unprecedented scale in the United States and worldwide. However, public concerns about the vaccine—which are exacerbated by misinformation and distrust—continue to be a feature of its distribution. This has brought new urgency to the need for effective approaches to build vaccine confidence, address access barriers, and encourage uptake. The pandemic has disrupted the supply chain for vaccines and, in many settings, has interrupted or halted routine immunization programs for people of all ages. Examples of these interrupted vaccination services include childhood vaccinations (Santoli et al., 2020), the human papillomavirus vaccination (Gilkey et al., 2020), and those for vaccine-preventable diseases. The COVID-19 pandemic is also likely to affect vaccine uptake during seasonal influenza vaccination season, which already varies widely by state (Wexler et al., 2020).

WORKSHOP OBJECTIVES

On August 17–20, 2020, a planning committee convened by the Forum on Microbial Threats at the National Academies of Sciences, Engineering, and Medicine held a 4-day virtual workshop titled *The Critical Public Health Value of Vaccines: Tackling Issues of Access and Hesitancy*.¹ This workshop was the second of a series of two workshops on the critical value of vaccines. The workshop gave particular consideration to health systems, research opportunities, communication strategies, and policies that could be considered to address access, perception, attitudes, and behaviors toward vaccination. The workshop featured presentations on two main topic areas: vaccine access and vaccine confidence. Specific topics included the following:²

¹ The planning committee's role was limited to planning the workshop, and the Proceedings of a Workshop was prepared by the workshop rapporteurs as a factual summary of what occurred at the workshop. Statements, recommendations, and opinions expressed are those of individual presenters and participants and are not necessarily endorsed or verified by the National Academies of Sciences, Engineering, and Medicine, and they should not be construed as reflecting any group consensus.

² The full Statement of Task is available in Appendix A.

- The global impact of declining immunization rates on vaccine-preventable diseases from lack of access;
- Trends and indicators used to monitor attitudes surrounding vaccine safety and efficacy, including a focus on regional and cultural differences;
- The complex determinants of vaccination that hinder or promote vaccine uptake;
- The role of health systems and professionals in improving access, influencing vaccine behavior, protecting at-risk communities from vaccine-preventable disease outbreaks, and preserving and building confidence in immunization strategies and practices;
- The role of media, anti-vaccine networks, and online misinformation in reinforcing anxieties about vaccine safety and drivers of vaccine hesitancy;
- Communication approaches that could help assuage anxieties about vaccine safety and strengthen public trust in science and health professionals;
- The ethics and effectiveness of legislation that aims to address vaccine hesitancy; and
- Potential priority actions—as well as partnerships and collaborations among policy makers, health professionals, national and international health organizations, parents, and community groups—to increase immunization access and vaccine confidence.

ORGANIZATION OF THE PROCEEDINGS OF THE WORKSHOP

In accordance with the policies of the National Academies, this Proceedings of a Workshop will not attempt to establish any conclusions or recommendations about needs and future directions, focusing instead on information presented, questions raised, and improvements suggested by individual workshop participants. Chapter 2 presents the workshop's two keynote addresses, which addressed the effect of the COVID-19 pandemic on vaccination uptake and access, the state of global vaccine confidence, and strategies to counter vaccine hesitancy. Chapter 3 assesses the current state of vaccine-preventable diseases worldwide and examines approaches to improve access to vaccines and close the global immunization gap. Chapter 4 focuses on the global and local drivers along the continuum of vaccine hesitancy that affect vaccine behavior. Chapters 5 and 6 explore opportunities to employ a systems approach to building confidence and increasing uptake and includes a legal perspective of vaccination policies, with Chapter 5 examining opportunities in research, communication, legislation, and technology and Chapter 6 focusing on community-based approaches. Chapter 7 summarizes the plenary presentation on new vaccines in the midst of an

outbreak, a panel on inoculating against misinformation and rebuilding the public's trust, and visionary statements on priorities in building vaccine acceptance and uptake for the next generation.

2

Global Vaccine Uptake During the COVID-19 Pandemic and the State of Vaccine Confidence

The workshop featured two keynote addresses delivered during a session moderated by Matthew Zahn, medical director at the Orange County Health Care Agency's Division of Epidemiology and Assessment. Ann Lindstrand, Expanded Programme on Immunization (EPI) coordinator at the Department of Immunization and Biologics at the World Health Organization (WHO), described the global impacts of the coronavirus disease 2019 (COVID-19) pandemic on vaccination uptake (demand-side factors) and access (supply-side factors). She discussed findings from various global efforts to collect data about the pandemic's effects as well as efforts under way to address numerous vaccine-related concerns that have come to the fore during the pandemic. Saad B. Omer, director of the Yale Institute for Global Health, explored the global state of vaccine uptake and potential strategies to enhance that uptake. He discussed early warnings related to the COVID-19 pandemic, trends and factors contributing to vaccine hesitancy, and approaches for promoting acceptance of forthcoming COVID-19 vaccines.

IMPACT OF THE COVID-19 PANDEMIC ON IMMUNIZATION SERVICES AND ACCESS

Presented by Ann Lindstrand, World Health Organization

Lindstrand described how the COVID-19 pandemic has disrupted immunization services and interrupted essential health services worldwide (see Box 2-1). She highlighted pandemic-related factors affecting both the

BOX 2-1
Immunization Service Interruptions Caused
by the COVID-19 Pandemic

- Service delivery disruptions and mass vaccination campaign suspensions
- Decreased access owing to physical distancing and transportation reductions
- Concerns by caregivers and health workers about COVID-19 exposure
- Supply chain interruptions
- High-risk populations at increased risk for immunization inequity, COVID-19 morbidity and mortality, and economic downturn

SOURCE: Lindstrand presentation, August 17, 2020.

supply chain and the demand for routine immunizations, as well as the indirect effects of service disruptions. She also discussed the forthcoming challenges involved in the large-scale administration of a vaccine for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent of COVID-19, while simultaneously carrying out catch-up activities.

Rapid Assessment of Continuity of Essential Health Services

Lindstrand presented preliminary results from WHO's Rapid Assessment of Continuity of Essential Health Services during the COVID-19 pandemic, a comprehensive survey of the pandemic's impact on 25 essential health services across the life course that was conducted with the following aims:¹ (1) to understand the extent of service disruptions across all services; (2) to assess prevailing mitigation strategies for maintaining services; and (3) to identify priorities and targets for technical assistance. Lindstrand explained that the methodology involved sending the online survey of essential health services, including vaccination, to all countries in the world on May 15, 2020, to be completed by July 6, 2020. A total of 103 countries responded, with national ministry of health (MOH) counterparts submitting responses directly or with facilitation through WHO country offices.²

Survey data indicate that routine immunization, provided both via outreach and at fixed health facilities, are some of the most negatively affected

¹ More information about the pulse survey on the continuity of essential health services during the COVID-19 pandemic is available at https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS_continuity-survey-2020.1 (accessed November 4, 2020).

² Response rates by region: WHO South-East Asia Region (82 percent); WHO Western Pacific Region (69 percent); WHO African Region (64 percent); WHO Regional Office for Europe (62 percent); WHO Regional Office for the Eastern Mediterranean (59 percent).

health services during the COVID-19 pandemic, said Lindstrand. Routine immunization outreach has been the third-most affected health service, after dental and rehabilitation services, with partial or complete service disruption reported in 70 percent of the 89 responding countries. In 60 percent of 103 responding countries, routine immunization services provided at fixed health facilities have reported disruptions. All of the 25 essential health services included in the survey had countries reporting both partial and complete disruptions during the COVID-19 pandemic, with disruption rates ranging from 19 to 77 percent of responding countries. Lindstrand maintained that achieving a “new normal” after the pandemic will likely require working toward a comprehensive package of health services with greater horizontal integration of services that are currently administered vertically.

Pulse Poll on Immunization Disruptions

WHO also developed a survey in collaboration with the United Nations Children’s Fund (UNICEF); Gavi, the Vaccine Alliance; the U.S. Centers for Disease Control and Prevention (CDC) Global Immunization Division; the Sabin Vaccine Institute’s Boost Initiative; and the International Vaccine Access Center at Johns Hopkins to monitor the global effects of the COVID-19 pandemic on immunization services—particularly during May 2020. Lindstrand noted that this poll was not intended to replace other immunization data-collection efforts but to take a quick snapshot of the impact of the COVID-19 pandemic across the world. The co-developers shared the poll through their networks, rather than directly contacting MOHs. A total of 260 respondents from 82 countries and territories completed the survey during the polling period of June 5–20, 2020. The respondents came from three distinct organization categories: (1) MOHs; (2) WHO, UNICEF, and Gavi; and (3) other types of organizations, including public and private health facilities, nongovernmental organizations, faith-based organizations, and National Immunization Technical Advisory Groups.³ All six WHO regions were represented in both national and subnational survey responses, with the majority of respondents coming from the WHO African Region.

Lindstrand noted that of the 82 respondents, 61 represented national-level vaccination efforts, while 21 represented efforts at a subnational level. Of the national-level respondents, 44 percent indicated disruptions in fixed-post immunizations. The most affected regions in May 2020 were those administered by the WHO Regional Office for the Americas (AMRO)

³ National Immunization Technical Advisory Groups are independent groups of experts that advise national governments on issues related to immunizations and vaccines. More information is available at https://www.who.int/immunization/sage/national_advisory_committees/en (accessed April 2, 2021).

and the WHO Regional Office for South-East Asia, with 75 percent and 71 percent of respondents, respectively, reporting disruptions. Lindstrand explained that outreach vaccination activities were more disrupted than fixed-post immunization services.⁴ In looking at the 65 unique nations represented in the outreach response data, 58 percent reported service disruptions and 11 percent indicated suspension of outreach activities. For the region administered by the WHO Regional Office for Africa (AFRO), the percentage of nations indicating outreach disruptions in May 2020 was as high as 86 percent.

Disruptions in Immunization Availability

To understand global-level vaccination service disruptions, WHO researchers explored possible factors related to the COVID-19 pandemic, said Lindstrand. The most commonly reported reason was low availability of personal protective equipment (PPE) for health care workers, with 49 percent of national and subnational respondents indicating this as a contributing factor. Other disruption factors include low availability of health care workers (43 percent), travel restrictions (40 percent), limited availability of vaccines or immunization supplies such as syringes (24 percent), and national policies related to immunization services (15 percent). Lindstrand noted AMRO and AFRO particularly had challenges in accessing PPE. AMRO and the WHO Regional Office for the Western Pacific indicated the highest levels of lack of availability of health care workers because of employees being diverted for pandemic response.

Immunization Demand Disruptions

Lindstrand described a substantial decrease in reported demand of vaccination services, with 73 percent of the 62 responding nations indicating disruption in demand. This was most significant in AFRO, with 89 percent of respondents reporting demand disruptions, but was present in all six regions. Lindstrand asserted that survey data indicate this decrease was not caused by public concern about routine immunizations but rather due to ramifications of the COVID-19 pandemic. The top user concern was risk of increased exposure to COVID-19 by coming to a facility for a vaccination, cited by 48 percent of respondents.⁵ Additional reasons included being unable to travel to a vaccination facility because of limited public transport, lockdowns, or physical distancing policies (33 percent); user uncertainty as to whether routine

⁴ More information about disruptions to vaccination caused by COVID-19 is available at https://www.who.int/immunization/monitoring_surveillance/immunization-and-covid-19/en (accessed November 4, 2020).

⁵ Percentages are weighted by number of respondents per country.

vaccination services remained available (10 percent); and user concern about increasing risk of exposure to COVID-19 by leaving their home (6 percent).

Addressing Disruptions in Immunization Demand

The survey assessed whether plans have been put in place to address the trend of decreasing demand, Lindstrand said. About 85 percent of the 54 countries that responded to this portion of the survey reported having plans to increase vaccine demand. The majority of respondents (82 percent) reported efforts involving awareness building, community engagement, and social mobilization. Tactics to increase awareness include mass media (e.g., television, radio, newspaper); engagement through community leaders, including religious leaders; and house-to-house outreach to encourage caregivers to continue their child's immunization schedule. Enhanced in-home service outreach efforts were reported by 13 percent of respondents, with the intention of mitigating concerns about crowding at health facilities. Other plans included increased infection prevention and control measures, training of health care workers, and research into reasons behind missed vaccinations. Lindstrand added that support from Gavi, WHO, UNICEF, and many other organizations has increased preventive measures, but this is not sufficient to fully address the downward trend in demand.

The survey also assessed concerns about rumor and misinformation regarding COVID-19 and immunization. Approximately 74 percent of respondents reported that their countries have been tracking rumors and misinformation. The channels being used to monitor misinformation include mainstream media (68 percent of respondents), digital media (65 percent), community reporting (55 percent), and other channels (4 percent). The monitoring emphasis on different channels varied by WHO region. Determining responses to different rumors is a current area of discussion, Lindstrand added.

Efforts to vaccinate groups of persons who may have missed their vaccines were assessed. The majority of respondents (77 percent) indicated their country, province, or district had been planning group vaccination activities. Planned efforts include outreach activities (64 percent); fixed routine immunization (59 percent); periodic intensification of routine immunization (PIRI) via "child health/vaccination days," "health weeks," or other efforts (40 percent); and supplemental immunization activity (28 percent). Lindstrand said WHO regional offices are supporting countries in determining how to reach those who missed immunizations during the COVID-19 pandemic. These catch-up plans have already been put into action in some areas.⁶

⁶ More information about WHO guidance for planning and implementing catch-up vaccination is available at https://www.who.int/immunization/programmes_systems/policies_strategies/WHO_Catch-up_guidance_working_draft_11.08.20.pdf?ua=1 (accessed November 4, 2020).

Lindstrand emphasized that demand-related issues stem both from family concerns and from the health care system. Family concerns include lockdowns, distancing policies, risk of increased exposure to COVID-19 during routine immunizations, and the safety of public transport. Lack of awareness about the continuity of routine vaccination services and fears related to misinformation and rumors also negatively affect family immunization demand. According to Lindstrand, health care system issues include health workers lacking motivation or being diverted toward the COVID-19 pandemic response, having safety fears about their own susceptibility to COVID-19, and concerns related to pandemic response and lockdown. She noted that some factors affect both family-related and staff-related decreases in demand. These include lack of PPE and training in infection prevention and control, lack of vaccine resources, capacity limitations, and vaccine delivery suspension caused by the COVID-19 pandemic. Lindstrand said the lack of PPE has made it especially difficult for parents and health care workers to participate in effective immunization services.

Not only has the COVID-19 pandemic been affecting routine immunizations, it has also been causing disruptions in other ongoing health services around the world, said Lindstrand. For example, measles surveillance, notification, and case investigations have been suspended or disrupted in many countries. As potential causes of these service interruptions, she cited lack of equipment, difficulty in obtaining supplies, and workforce shortages caused by diverting health care workers and surveillance monitoring officers toward the pandemic response. Additionally, 56 countries reported postponing at least one vaccine-preventable disease immunization campaign because of the COVID-19 pandemic; the majority of vaccines affected by these disruptions were related to measles or polio. WHO has estimated that 178 million people may be at risk of missing measles shots in 2020 because of decreased campaigns and outreach. Relative differences in administered doses of diphtheria, tetanus, and pertussis vaccine dose 3 in 2019 versus 2020 reveal steep decreases in March and April across WHO regions (see Figure 2-1). Lindstrand explained these data illustrate the severity of the coverage decrease, the ramifications of which will depend on whether countries can effectively increase efforts to reach those who have missed immunizations.

Mitigating the Effects of the COVID-19 Pandemic

The indirect supply-side and demand-side effects of the COVID-19 pandemic are also worrisome, said Lindstrand. A modeling study looked at the indirect effects of the COVID-19 pandemic on maternal and child mortality in 118 low- and middle-income countries to estimate the additional maternal and under age 5 child deaths associated with disruptions to the health system and decreased access to food (Robertson et al., 2020). Accounting for factors

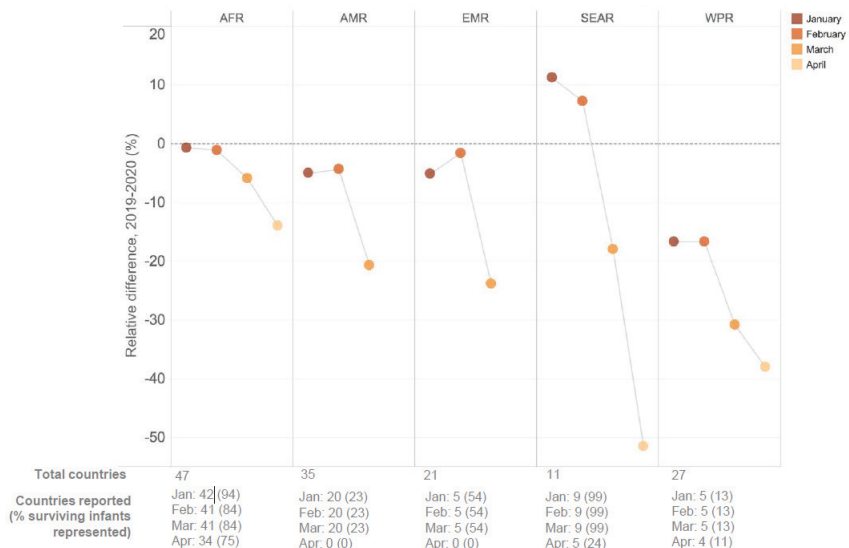


FIGURE 2-1 Relative differences in diphtheria, tetanus, and pertussis vaccine dose 3 (2019 versus 2020).

NOTES: Countries reporting by WHO region. AFR = WHO African Region; AMR = WHO Region of the Americas; EMR = Eastern Mediterranean Region; SEAR = South-East Asia Region; WPR = Western Pacific Region.

SOURCES: Lindstrand presentation, August 17, 2020; administrative data received from member states until July 6, 2020 (data likely incomplete for 2020).

affecting both provision and use of health services, the study presents three possible scenarios featuring varying levels of reduction of essential maternal and child health interventions. All scenarios indicate that postponing immunizations will result in a substantial number of additional child deaths per month: tetanus toxoid vaccination (1,910–6,610 deaths); measles vaccine (1,030–3,260 deaths); diphtheria, tetanus, and pertussis vaccine (950–2,890 deaths); *Haemophilus influenzae* type B vaccine (560–1,720 deaths); and pneumococcal conjugate vaccine (460–1,410 deaths).

In an effort to mitigate these indirect effects, WHO has been issuing guidance to support countries (WHO, 2020a,b). This has included guiding principles on maintaining immunization services during the COVID-19 pandemic for all countries, which Lindstrand noted prioritizes immunization as a core health service. Although countries were initially advised to temporarily suspend mass vaccination campaigns, WHO has backed away from this advice if the vaccine campaigns can be implemented safely. The guidance encourages maintaining ongoing routine immunization delivery with protection measures against COVID-19 in place. Furthermore, she added that

countries are urged to plan for catch-up vaccination as early as possible and implement catch-up activities in parallel with ongoing services. In August 2020, WHO released guidance regarding the planning and implementation of catch-up vaccination programs that addresses the following components:

- Strategies for catch-up vaccination;
- Vaccines and supplies;
- Data systems, tools, recording, and reporting;
- Health worker knowledge and practice; and
- Communications and community engagement.⁷

Lindstrand noted that this guidance includes information on how to properly organize safe immunization sessions during the COVID-19 pandemic.

How to implement the new COVID-19 vaccines quickly and safely continues to be a major concern, said Lindstrand. A balance will need to be struck between administering 2 billion doses of a new vaccine and continuing uptake of routine immunizations. She suggested that achieving a high level of COVID-19 vaccine uptake will involve building public knowledge and awareness while enhancing confidence; anticipating risks and communicating them effectively and early; and informing national policy making, planning, and implementation.

Catch-up efforts to increase the uptake of routine immunizations will involve embedding the value of vaccination in all strategies and messages (including in the implementation of the new COVID-19 vaccines), ensuring that planning is informed by the latest evidence and data, and building capacity at local levels to tailor and implement demand management strategies.

GLOBAL VACCINE CONFIDENCE AND STRATEGIES TO ENHANCE UPTAKE

Presented by Saad B. Omer, Yale Institute for Global Health

Omer presented three warnings he issued at the outset of the COVID-19 pandemic in the United States, and then he explored the state of global vaccine hesitancy. He presented data that showed how attempting to correct misinformation can backfire, and he introduced an approach to addressing vaccine hesitancy based on the Moral Foundations Theory.

⁷ More information about WHO guidance for planning and implementing catch-up vaccination is available at https://www.who.int/immunization/programmes_systems/policies_strategies/WHO_Catch-up_guidance_working_draft_11.08.20.pdf?ua=1 (accessed November 4, 2020).

Three Warnings at the Outset of the COVID-19 Pandemic

Omer's opinion piece "Is America Ready for Another Outbreak?" was published in *The New York Times* on January 23, 2020, 2 days after CDC confirmed the first case of COVID-19 in the United States (Omer, 2020). Omer said that at the time of publication, experts were already seeing concerning signs (although they had not yet given the syndrome its official name of COVID-19), and these concerns spurred him to write the piece. Even though he could not have predicted the height of eventual case and mortality burdens, he was concerned about the state of preparedness. To that end, he issued three warnings and suggested strategies that the country should take in preparing for and responding to the COVID-19 outbreak.

The first warning was to let the scientists lead the response effort. Omer explained that communications research, pandemics research, and experience with pandemics all suggest that messaging from an authoritative, scientific perspective is more trusted than information from other sources. A pandemic is a dynamic situation with a rapidly evolving evidence base; thus, the response effort depends on the ability to synthesize and assimilate emerging and evolving evidence and translate that evidence into action. He added that well-respected scientists and public health professionals are best able to clearly communicate that evidence to the public—including uncertainty about the evidence.

Secondly, Omer warned against providing false assurances to the public during a pandemic. Evidence from public health emergencies, including outbreaks, indicate that public authorities and political leaders tend toward providing assurances. This instinct is understandable and may help to calm the public in the short term. However, over the longer term, assurances that are not supported by evidence can lead to the loss of public trust and can hamper the ability to communicate mass recommendations that may be challenging.

Thirdly, Omer warned about the consequences of scientific and public misinformation. He said that at the time of his opinion piece, misinformation was already spreading about COVID-19. The pandemic has fueled the propensity of researchers to share output early on, resulting in an explosion in preprint publications, he added. Preprints can be a useful tool when sharing nascent information in a rapidly evolving data landscape. However, Omer contended, when information has not gone through the critique and quality control measures involved in peer review, it can exacerbate the issue of premature data release muddling public understanding. He described his three warnings as prescient in terms of their implications for communicating about the COVID-19 pandemic and specifically about COVID-19 vaccines.

Addressing Vaccine Hesitancy

Vaccine hesitancy is a widespread, heterogeneous phenomenon, said Omer. According to his research, 2013 data suggest that some level of vaccine hesitancy—or “soft demand”—is present in most countries worldwide. The Vaccine Confidence Project conducted a 2019 survey that asked respondents whether they agreed with the statement “I think vaccines are safe.”⁸ The responses by country were heterogeneous, with hot spots of vaccine hesitancy in Eastern Europe, France, Japan, South Korea, and other nations. Not all attitudes lead to actual vaccine refusal, he noted, but attitudes should be monitored at the global level on an ongoing basis.

Potential Backfire Effect of Correcting Misinformation

When confronted with patients citing misinformation about vaccines, it is the logical and intuitive response of clinicians to correct such misinformation. However, Omer pointed out that what little evidence there is on the usefulness of correcting misinformation is nuanced and multidimensional. For instance, a 2015 study on the limitations of fact-based messaging measured the effect of this approach by studying parents coming to doctors’ offices for pediatric vaccinations (Nyhan and Reifler, 2015). Parents were divided into three groups based on their baseline attitudes toward vaccines: most favorable, somewhat favorable, and least favorable. Various interventions were conducted and measured, including images, narratives, risks, correction, and a control group. The results of this study revealed a “backfire effect of correcting information” in which parents who were least favorable toward vaccines had a lower propensity toward vaccination after the intervention. Omer noted that the data are nuanced—not all myth correction has produced the backfire effect—but using the correction of misinformation as the go-to intervention strategy warrants caution.

Recognizing Underlying Values

In looking for more effective strategies to address vaccine hesitancy, Omer and colleagues have looked at people’s underlying values. According to the Moral Foundations Theory,⁹ everyone has underlying values that operate somewhat similarly to taste buds. That is, the five primary tastes (i.e., bitter, salty, sweet, sour, umami/savory) are experienced through the permutation of the taste buds evoked by a food, but also via an individual’s

⁸ More information about the Vaccine Confidence Project is available at www.vaccineconfidence.org (accessed November 4, 2020).

⁹ More information about the Moral Foundations Theory is available at <https://moralfoundations.org> (accessed November 8, 2020).

underlying propensity to certain flavors (Chandrashekar et al., 2006). The Moral Foundations Theory identifies six “moral taste buds” that the authors of the theory call moral foundations (Haidt, 2012). These six moral foundations are care/harm, fairness/cheating, loyalty/betrayal, authority/subversion, purity/degradation, and liberty/oppression. The six foundations are emphasized differently in various populations, he noted, and stimuli can evoke different combinations of these values.

Omer explained how the Moral Foundations Theory specifies each value and makes it measurable, allowing the values to inform interventions. The moral foundation of care/harm is the most hardwired, he noted. Care/harm creates the urge to protect lives and fuels the desire to cuddle cute animals. Fairness/cheating is exhibited in the “golden rule” common in most ethics systems and underlies people’s inherent reactions to unfair situations. Loyalty/betrayal is a foundation for national pride, sports fandom, and other forms of manifesting allegiance; it also underlies feelings of betrayal when loyalty is lacking. Authority/subversion accounts for why some people are more submissive to authority than others. Purity/degradation can be a religious-valence-based concept or a secular concept (e.g., when people do not want to put toxins in their bodies). Liberty/oppression is also a common value, he added.

Omer and colleagues conducted a study in the United States that demonstrated for the first time that vaccine decisions can be value-based decisions (Amin et al., 2017). By assessing vaccine hesitancy and the values of authority, fairness, harm, loyalty, purity, and liberty, they found that people who were more likely to be accepting of vaccines also tended to emphasize the authority foundation and defer to their physicians’ recommendations. Those who were most hesitant to have vaccines tended to emphasize purity and liberty.

Appealing to Values to Change Behaviors

Omer explored how this understanding of vaccine behavior as a set of value-based decisions can be operationalized by appealing to—rather than attempting to change—people’s values. Recently, Omer and colleagues looked at whether purity and disgust can be used to increase human papillomavirus (HPV) infection vaccination (James et al., 2020). Many countries have poor vaccine coverage in teens aged 11–15, which puts them at increased risk of infection in college, when sexual activity tends to increase and vaccines are less likely to be effective. The primary approach used to increase acceptance of HPV vaccines is emphasizing the impact on cancer. Although this approach is appropriate, there are noted substantial limitations to the use of cancer-based and severity-based messages for HPV in this college age group, he noted. In a randomized controlled trial, participants

were presented with images and a narrative about genital warts that emphasized how the disease can violate purity values. Participants in the treatment arm were about 20 percent more likely to receive the HPV vaccine within the subsequent 6 months than those in the control arm, said Omer.

Narratives Over Statistics

Omer described how narratives of disease severity can resonate more effectively than statistical probabilities. He noted that humans are “excellent linguists but poor statisticians,” as demonstrated by the difficulty people have in conceptualizing statistics in their perception of risk. For example, even experts may not be able to comprehend the difference between a risk of 1 in 10 million versus 1 in 100 million in a visceral way. One way to think about this phenomenon is by focusing on availability heuristics, which hold that “people judge the probability of events by the ease with which instances could be brought to mind” (Tversky and Kahneman, 1973). Therefore, the actual frequency of an event does not necessarily affect perception of probability. For instance, people tend to be more afraid of flying than of driving even though the actual risk of the latter is greater. This may be attributed to the vividness with which plane crashes are reported, while car crashes are treated as a norm unless they stand out markedly from the usual pattern, he suggested.

In a 2013 study examining the effect of statistics on parents’ vaccination decisions, parents were presented with different conditions and the associated risks of vaccination versus non-vaccination (Sadique et al., 2013). For example, participants were told the chance of having a vaccine-associated side effect is 20 in 100,000, whereas the chance of contracting the disease if not immunized is 20,000 in 100,000—representing a 1,000-fold difference. The researchers manipulated the conditions to see if this had an effect on vaccine acceptance. Even though the risk of an unvaccinated child contracting a disease is much higher than having a vaccine-associated adverse event, presenting those relative risks to parents did not affect vaccine hesitancy. Rather, it was the perceived severity of the disease or adverse event that affected vaccination acceptance. Furthermore, parents tended to exhibit omission bias, anticipating more regret from a decision to vaccinate than not to vaccinate, because they conceived of vaccination as active and non-vaccination as passive. Omer suggested approaching vaccine hesitancy by framing vaccination as a routine act and non-vaccination as an active decision, rather than the converse; the limitations to this approach could potentially be addressed with a focus on values.

Promoting COVID-19 Vaccine Acceptance in the United States

To look at acceptance of a COVID-19 vaccine in the U.S. population, Omer and colleagues administered a survey and found that nearly 70 percent of people were outright accepting or more accepting of a vaccine (Malik et al., 2020).¹⁰ Those with more vaccine hesitancy were not necessarily rejecting vaccines that prevent COVID-19; rather, they had concerns at that point in time, which made them uncertain as to whether they would eventually accept the vaccine. Furthermore, Omer and colleagues found vaccine acceptance varied by region in the U.S. population (Malik et al., 2020). Slightly more than half of U.S. states had acceptance rates ranging from 60 to 75 percent. Segments of the U.S. Midwest and Southwest regions had the highest rates of vaccine acceptance (> 75 percent) while the Southeast region had lower rates of acceptance (50–60 percent). The lowest acceptance rates (< 50 percent) were in the Great Lakes region. Omer and colleagues then developed and evaluated a predictive model based on commonly available demographic data, which is the subject of ongoing research to examine whether interventions can be targeted more directly to small population groups.¹¹

Contending with Myths

Omer noted that there are times when correcting a myth is unavoidable. An approach developed in 2011 to address climate change communication suggests that instead of emphasizing the myth itself, efforts should focus on asserting that it is a myth (Cook and Lewandowsky, 2011). An example of this approach provided by Omer would be replacing inappropriate headlines such as “Does MMR Vaccine Cause Autism?” and “Are COVID-19 Vaccines Unsafe?” with headlines such as “The Myth of MMR Being Associated with Autism Refuses to Go Away,” Omer suggested. The clear assertion that the information is incorrect can be bolstered with factual evidence pointing out falsity. Ultimately, the myth should be replaced with the best alternative explanation to prevent the dispelled myth from reemerging in people’s minds. Omer closed by presenting an overview of the current evidence about effective strategies to address vaccine hesitancy (see Box 2-2).

¹⁰ For more information on Omer’s survey work regarding COVID-19 vaccines and public opinion, see [https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370\(20\)30239-X/fulltext](https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(20)30239-X/fulltext) (accessed March 2, 2021) and <https://pubmed.ncbi.nlm.nih.gov/33390295> (accessed March 2, 2021).

¹¹ This research had been accepted for publication only days prior to the time of the workshop, so it was not discussed any further. For the fully published results, see <https://europepmc.org/article/MED/32838242> (accessed March 2, 2021).

BOX 2-2
Lessons from Current Evidence on Strategies
to Increase Vaccine Acceptance

- Do not affirm a misperception.
- Avoid lingering on a myth.
- Connect to people's values.
- Account for anticipatory behavior.
- Focus on narratives.
- Do not offer false assurances.

SOURCE: Omer presentation, August 17, 2020.

DISCUSSION

Addressing Vaccine Hesitancy Related to Development Speed

Zahn asked Omer and Lindstrand about approaches to address fears and vaccine hesitancy that are specifically related to the speed at which the COVID-19 vaccines are being developed, tested, and approved. Omer replied that the first step is to ensure these vaccines are developed using mainstream pathways. He elaborated that while it will be appropriate and necessary to find efficiencies in the process, the vaccine development timeline ought to be sped up by making the process more efficient rather than by skipping critical steps. To illustrate how efficiencies could be identified, he noted that the mainstream vaccine community views phase 3 trials as the cornerstone of evaluating efficacy and safety in the population. Often, this is conducted by evaluating large samples and making calculations based on the number of disease or infection incidents (referred to as “events”) that occur in the intervention arm versus the control arm. One method is to conduct large-scale trials with a large enough sample size to capture events over a shorter time frame with equivalent statistical significance. This approach has been adopted in COVID-19 vaccine trials, Omer noted, and vaccine developers have been able to find efficiencies to speed up the process without undermining the reliability of clinical data or information.¹² Omer suggested communicating both the “why” and the “how” of efficiency implementation in the COVID-19 vaccine development process as a way to reassure the public that corners are not being cut.

¹² This is an abbreviated explanation of the vaccine trial design for COVID-19. More detail can be found at https://media.tghn.org/articles/Vaccine_Efficacy_V1.0_7_May_20.pdf (accessed December 17, 2020).

Strategies for Tracking Vaccinations Around the World

Zahn noted that many countries do not have detailed strategies for name-based tracking of children who may have missed their vaccination schedules. He asked Omer and Lindstrand about approaches at the facility and national level for documenting and effectively tracking children who require catch-up vaccinations. Lindstrand replied that this question is pertinent for understanding how to best serve a child in administering a corrective immunization schedule after it has been delayed. To address this issue, WHO is promoting home-based records. Although digital solutions are enticing, efforts to create an electronic immunization registry that works well for everyone have so far not been successful. She suggested focusing on the basics: census data, home-based records, reporting, and a documentary instrument the public views as valuable enough to keep and bring along when receiving health services. She added that tracking COVID-19 vaccinations during the pandemic will give rise to further challenges, because these campaigns will extend beyond EPI's typical target groups. Instead, the vaccine will likely be deployed to essential health care and social workers, older people, and people at higher risk owing to comorbidities. Lindstrand noted the lack of good instruments and procedures for reporting and follow-up; she was hopeful that the rapid development and implementation of the COVID-19 vaccine would help to fast-track the implementation of data-collection systems as well.

Accelerated Vaccination Schedules

Zahn asked about evidence related to accelerated or catch-up vaccination schedules in which multiple vaccines may be administered simultaneously. Lindstrand said it has generally been proven safe to receive multiple vaccines at the same time, including both live attenuated and other vaccines. "The human body is fantastic in being able to respond to many antigens at the same time," she remarked. However, recommendations about the timing and spacing between different doses should be adhered to, she said. For example, if guidance about the timing of vaccine schedules (e.g., the new catch-up guidance based on WHO's recommended vaccination schedules) is not followed, the long-term immunologic response may not be high enough to be protective.

Ensuring the Safety of the COVID-19 Vaccine

Given that COVID-19 can potentially cause long-term morbidity, Zahn asked how the safety of the vaccine can be assured—particularly with respect to longer-term potential health risks. Omer noted that the ongoing

ing vaccine trials are designed with large sample sizes to provide a good denominator and build confidence in moving forward with implementation. He emphasized the need to pool data from individual trials to help identify vaccine-specific adverse events as well as issues common to all vaccines for a particular pathogen. A larger body of pooled data enables better safety evaluation before the vaccination program is rolled out; it is also critical for post-marketing surveillance systems to continuously evaluate the safety of these vaccines, he added.

Omer outlined three pillars of vaccine safety reports on the use of COVID-19 vaccines. The first is the Vaccine Safety Datalink, a collaborative project between CDC and health care organizations that links databases of health maintenance organization–based networks and covers a substantial proportion of the U.S. population. Examining background rates before a vaccine is rolled out can help to identify any additional risk. He added that a separate initiative from the U.S. Food and Drug Administration, the Sentinel Initiative,¹³ will also likely be involved with evaluating post-marketing safety of COVID-19 vaccines as they are rolled out. The second pillar is WHO’s Global Advisory Committee on Vaccine Safety (GACVS), which is developing a set of predefined potential adverse effects for pharmacovigilance systems. In addition, GACVS is working to enhance country preparedness and help coordinate the collection of safety data worldwide. To support the third pillar—risk communication planning—GACVS has a subcommittee dedicated to risk communication activities for the vaccine, Omer added.

COVID-19 Vaccine Delivery Infrastructure

Zahn asked about international-level efforts to build the infrastructure necessary to deliver a novel vaccine worldwide in a short period of time. Lindstrand noted that the Access to COVID-19 Tools Accelerator is a global collaborative effort to accelerate the development and production of COVID-19 diagnostics, therapeutics, and vaccines, and ensure equitable access to these products.¹⁴ One of the pillars of this effort is the logistics systems for delivering vaccines. The delivery and readiness work stream within the accelerator is a joint effort among UNICEF, WHO, and Gavi, she added. Efforts are focused on helping countries prepare for likely scenarios over the next 1–2 years in terms of volumes and cold chain requirements. Lindstrand added that the majority of vaccines will go through the COVAX

¹³ More information about the Sentinel Initiative is available at <https://www.fda.gov/safety/fdas-sentinel-initiative> (accessed February 21, 2021).

¹⁴ More information about the Access to COVID-19 Tools Accelerator is available at <https://www.who.int/initiatives/act-accelerator> (accessed November 8, 2020).

facility organized by Gavi,¹⁵ then shipped or distributed through UNICEF's supply division. She noted that in high-income countries, it is possible that vaccines will be shipped directly from various pharmaceutical manufacturers. In collaboration with the Coalition for Epidemic Preparedness Innovations (CEPI),¹⁶ WHO is mapping out strategies to store and distribute potentially billions of vaccine vials. Lindstrand said there are many fronts on which CEPI and the organizations involved in COVAX are examining, adjusting, responding to, and identifying possible scenarios and trying to adopt all new evidence that emerges. Furthermore, they are working to keep WHO regional and national offices up to date. For instance, she explained how WHO plans to release a country readiness checklist for mapping out different target groups and timelines. She added that all WHO regions have also set up vaccine working groups to operationalize and adapt the global guidance according to regional need.

Omer emphasized that never before has the United States vaccinated adults in the numbers that will be needed to ensure an equitable level of protection against COVID-19 throughout communities. He suggested focusing on developing an immunization delivery plan. Remarking that “the ordinary often hampers the exceptional,” Omer noted that the bottlenecks in COVID-19 testing in the United States were not due to polymerase chain reaction technology, equipment, or primers.¹⁷ Instead, the bottlenecks were caused by lengthy turnaround times, limited availability of tests, and delays in scaling up. To implement a mass vaccination campaign in early 2021, the United States should have started preparing in March 2020, he warned, which underscores the need to set up a national adult vaccination program for COVID-19 with great speed.

¹⁵ More information about the COVAX facility is available at <https://www.gavi.org/covax-facility> (accessed November 8, 2020).

¹⁶ More information about the Coalition for Epidemic Preparedness Innovations is available at <https://cepi.net> (accessed November 8, 2020).

¹⁷ Polymerase chain reaction using specific primers is the basis of molecular diagnostic tests for detecting COVID-19 as well as other pathogens in the health care setting. More information on the science behind COVID-19 molecular tests can be found at <https://discoverysedge.mayo.edu/2020/03/27/the-science-behind-the-test-for-the-covid-19-virus> (accessed April 2, 2021).

3

Improving Access and Closing the Global Immunization Gap

The first session of the workshop focused on improving access and closing the global immunization gap. The session's objectives were to assess the current state of vaccine-preventable diseases globally, to delineate key barriers to dissemination and uptake of vaccines, and to examine evidence-based strategies to improve access to vaccines and increase immunization coverage both locally and globally. Anuradha Gupta, deputy chief executive officer at Gavi, the Vaccine Alliance, discussed how an equity lens can be used to close the global immunization gap by using the “zero-dose” conceptual framework to reach unvaccinated children. Litjen (L. J.) Tan, chief strategy officer at Immunization Action Coalition, explored strategies to reduce barriers to vaccination and increase vaccination uptake among adults. Momin Abdul Kazi, assistant professor at the Aga Khan University, Pakistan, examined opportunities and challenges in using mobile health (mHealth) interventions to improve vaccination coverage. Jeff Goad, chair of the Department of Pharmacy Practice at the Chapman University School of Pharmacy, presented on the role of community-based pharmacy interventions in improving access to vaccines and the potential for pharmacy-based immunization as a response to pandemics. The session was moderated by Noni MacDonald, professor in the Department of Pediatrics at Dalhousie University, Nova Scotia, Canada.

APPLYING AN EQUITY LENS TO IMMUNIZATION TO CLOSE THE GLOBAL IMMUNIZATION GAP

Presented by Anuradha Gupta, Gavi

Gupta described how viewing immunization through an equity lens can help to close the global immunization gap. She noted that the coronavirus disease 2019 (COVID-19) pandemic has exacerbated and compounded many long-standing inequities in global immunization as well as the vulnerabilities that underlie those inequities. To highlight the value of vaccination for ensuring equity, she invoked the words of Nelson Mandela: “Life or death for a young child too often depends on whether he is born in a country where vaccines are available or not.”

Progress in Closing the Vaccine Gap

Gupta distinguished between equity among and equity within countries, pointing out that the landscape of global vaccine equity has improved since Gavi was established in 2000. In the years since, the efforts of Gavi and others to scale up new vaccines has achieved substantial progress in improving children’s health outcomes worldwide and in closing the vaccine gap between low- and high-income countries. Gupta asserted that between 2000 and 2017, the scale-up of new vaccines contributed to a 44 percent decline in under-age-5 mortality in Gavi-supported countries¹ and a 71 percent decline in deaths from vaccine-preventable diseases. To illustrate the divergent trends in vaccine coverage for Gavi-supported versus non-Gavi-supported countries, she compared the coverage rates for *Haemophilus influenzae* type B, pneumococcus, and rotavirus vaccines. In 2010, the coverage rates for all three were higher in non-Gavi-supported countries than in Gavi-supported countries. However, according to Gupta, by 2019 this had reversed, with coverage rates in Gavi-supported countries exceeding those in non-Gavi-supported countries.² Although vaccination coverage has improved writ large, Gavi-supported countries have realized a faster expansion of coverage and a larger proportion of coverage than non-Gavi-supported countries. In

¹ For a list of Gavi-supported countries and eligibility criteria, visit <https://www.gavi.org/sites-support/sustainability/eligibility> (accessed May 20, 2021).

² In 2010, non-Gavi-supported countries had relatively high vaccine coverage rates for *Haemophilus influenzae* type B (45 percent), pneumococcus (24 percent), and rotavirus (18 percent), while Gavi-supported countries had relatively low vaccine coverage rates for *Haemophilus influenzae* type B (36 percent), pneumococcus (1 percent), and rotavirus (0 percent). In 2019, Gavi-supported countries had relatively higher vaccine coverage rates for *Haemophilus influenzae* type B (58 percent), pneumococcus (47 percent), and rotavirus (28 percent), while vaccine coverage rates in non-Gavi-supported countries in the same year were 81 percent (*H. influenzae* type B), 49 percent (pneumococcus), and 46 percent (rotavirus).

this case, upper- and middle-income non-Gavi-supported countries have struggled to introduce new vaccines. This is a peculiar case of inequity, Gupta said.

According to internal Gavi data, Gupta said more children are being reached with more vaccines. Between 2000 and 2019, the vaccination coverage rates increased for numerous vaccines throughout Gavi-supported countries, as shown in Table 3-1. In these countries, vaccination rates started at zero, but much progress has been made.

Progress Needed to Reach Underimmunized and Zero-Dose Children

Despite the great strides made in increasing vaccination coverage in Gavi-supported countries over the past two decades (see Figure 3-1), many children worldwide remain unimmunized or underimmunized, said Gupta. Only 11 percent of children in Gavi-supported countries receive the last recommended dose for each of the 11 antigens currently recommended by the World Health Organization (WHO).³ Gupta explained that the term *zero dose* is a new distinction being used in strategies developed by Gavi, WHO, and other partners to refer to individuals who have not received a single dose of diphtheria, tetanus, and pertussis vaccine (DTP). Historically, vaccination coverage for DTP dose 3 has been used as a proxy indicator of access to immunization. However, children who have not received a single dose of DTP are those most likely to be living in communities with compounded

TABLE 3-1 Vaccine Coverage in Gavi-Supported Countries (2000, 2019)

Vaccine	Vaccine Coverage (2000, %)	Vaccine Coverage (2019, %)
HIB3	0	81
PCV3	0	49
Rotavirus	0	46
MCV2	0	59
RCV1	0	57
IPV1	0	76
YFV	0	43

NOTE: HIB3 = *Haemophilus influenzae* type B dose 3; IPV1 = inactivated polio vaccine dose 1; MCV2 = measles containing vaccine dose 2; PCV3 = pneumococcal conjugate vaccines dose 3; RCV1 = rubella-containing vaccine dose 1; YFV = yellow fever vaccine.
SOURCE: Gupta presentation, August 17, 2020.

³ More information about Gavi and Gavi-supported countries is available at <https://www.gavi.org/sites/default/files/document/2020/Gavi-Facts-and-figures-June.pdf> (accessed November 3, 2020).

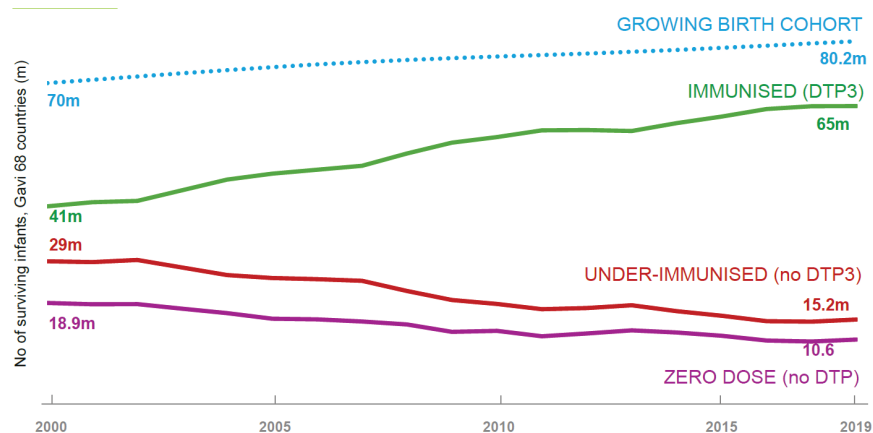


FIGURE 3-1 Zero-dose, underimmunized, and immunized children in Gavi-supported countries (2000–2019).

NOTE: DTP = diphtheria, tetanus, and pertussis vaccine; DTP3 = diphtheria, tetanus, and pertussis vaccine dose 3; m = million.

SOURCE: Gupta presentation, August 17, 2020.

vulnerabilities and deprivations that contribute to the lack of not only vaccine coverage, but also virtually all essential services, she added.

Gupta presented data showing the relationship between immunization status and the number of surviving infants in Gavi-supported countries between 2000 and 2019 (see Figure 3-1). During this time, the number of surviving infants who received DTP dose 3 increased, and the number of underimmunized and zero-dose surviving infants decreased. This trend reflects use of DTP dose 3 vaccination as a proxy indicator of access to vaccination. Gupta noted that the rate of decrease in underimmunized and zero-dose cohorts has plateaued since 2010.

Two-thirds of zero-dose children live in households surviving on less than \$1.90 per day. Gupta noted that this fact designates the zero-dose child as a bellwether of acute inequity and poverty in a community. In this sense, targeting zero-dose children can be used to identify communities where there are opportunities for multiagency, multi-sectoral action. For example, communities with zero-dose children also tend to have girls who are not in school; women with limited agency; high rates of violence against women; and lack of contraceptive, reproductive, maternal, neonatal, and pediatric health services. These communities are often the epicenters of disease outbreaks (e.g., yellow fever, measles, meningitis, cholera, Ebola virus disease) and can thus be valuable targets for prevention efforts. Traditionally, the risk of outbreaks in these communities has been addressed by maintaining

stockpiles and providing support for outbreak response.⁴ However, Gupta noted that reaching zero-dose children in these “missed” communities and ensuring that they receive on-time vaccinations can help mitigate the growth of an unvaccinated population and thus reduce said communities’ outbreak susceptibility.

Sustainable Framework for Reaching Zero-Dose Children and Underserved Communities

While zero-dose children present a valuable opportunity for retargeting vaccination efforts (and health service interventions more generally) to likely outbreak epicenters, there are huge challenges associated with identifying, reaching, and monitoring such children. Gavi has developed a new framework to sustainably target zero-dose children and underserved communities by leveraging new mindsets, approaches, and partnerships, said Gupta. The aim of this new framework is to leave no one behind in terms of immunization, and Gavi is advocating for dedicated funds to implement this framework to reach zero-dose children and underserved communities. The framework is a cyclical model that includes the following steps:

- Identify target populations (e.g., “who, where, why, how many?”).
- Reach populations through flexible approaches that address both supply- and demand-side barriers.
- Monitor progress and correct course as needed.
- Measure outcomes.
- Advocate for immunization using evidence from measured outcomes.

Gupta explained how allocating resources simply towards finding zero-dose children and their communities reveals not only their identities and locations but also the barriers they face and how they have arrived in their current situation. In contrast to the traditional emphasis on global approaches to vaccination—that is, a one-size-fits-all approach—Gavi has rapidly shifted toward flexible approaches for reaching zero-dose children and underserved communities, recognizing the need to use tailored strategies that account for supply-side and demand-side barriers. Global or regional strategies may still be applied, but they should be tailored to be ultra-local, community-based, community driven, and community owned, she added.

Gupta emphasized the value of good monitoring in order to allow for course correction and the evaluation of outcomes, noting that challenges often arise in the monitoring and measurement processes. According to

⁴ Since 2006, more than 140 million people have been protected with more than 170 million doses from Gavi-funded stockpiles and outbreak response.

Gupta, in the field of immunization, monitoring and measurement are currently conducted using annual estimates generated by a methodology reliant on occasional surveys. These estimates offer a sense of immunization trends, but they do not allow for real-time progress assessment. To ameliorate this, Gavi's framework calls for the establishment of "learning hubs" to help evaluate the impact of investments and approaches being used to increase vaccination coverage. These hubs can then produce data that can be used as evidence for advocacy efforts to bring the issue of zero-dose children into political discourse. Gupta claimed that an important reason why zero-dose children are neglected is because they are not seen and have no voice or political influence. She further emphasized that Gavi's framework calls for the continuous use of immunization data to advocate for investment in zero-dose children. This aspect of the framework is linked to efforts to create financial incentives that help trigger national conversations about prioritizing zero-dose children.

Recognizing That National Averages Mask Inequities

Because national averages and other macro-level data can mask inequities, Gavi has begun disaggregating data in the past 4 years to focus on subnational areas, Gupta said. For instance, Gavi has used subnational data to identify disadvantaged populations in Pakistan and Kenya. In Pakistan, various data sources were used to reveal exactly where zero-dose children live and to identify provinces, districts, and even city blocks with high zero-dose populations. In Kenya, geospatial mapping was used to identify disadvantaged populations in terms of DTP dose 1 coverage versus composite education and contraceptive use in areas of poor accessibility. Once clusters of disadvantaged children are identified, it is easier to support countries in addressing the needs of these children, she added.

Using Differentiated Strategies to Reach Zero-Dose and Underimmunized Children

Gupta explained how in recent years, Gavi has encouraged countries to adopt highly differentiated approaches, and are continuing to build on this strategy to strengthen efforts to reach underimmunized and zero-dose children. For example, the lived experiences of the population of Myanmar (Burma) can vary dramatically depending on social or geographic context. Gupta categorized certain regions based on the challenges in access: geographic hard-to-reach (H2R), due to dense forest and inaccessible mountain ranges; social H2R because of poor infrastructure or ongoing sectarian and state-sponsored violence; and active conflict zones. The country's poor urban cores and certain remote impoverished ethnic communities are home

to increasing populations of zero-dose children. Gupta claimed that overall population growth spurs the growth of poor urban populations, creating disease hotspots that go unreached by vaccination and other services. Additionally, Gupta said, other geographic and social H2R communities exist in inaccessible rural areas and thus lack access to services. Gavi encourages diverse countries like Myanmar to adopt a differentiated approach (e.g., by prioritizing districts based on service delivery and access challenges). Interventions can also be tailored for specific settings to (1) increase demand for immunization services; (2) expand cold chain access to underserved populations; (3) improve health infrastructure, workforces, transportation, and communication facilities; and (4) strengthen leadership and program management.

Broadening Partnerships to Enhance Services

Building well-designed partnerships to enhance immunization services is another area of focus for Gavi, WHO, and the United Nations Children's Fund (UNICEF), said Gupta. Several years ago, Gavi established a new country-centric partner engagement framework that aimed to shift technical support and investment from the global and regional level to national and subnational levels. This shift has resulted in a breadth of new partnerships. For instance, in Afghanistan, Gavi has partnered with the International Federation of Red Cross and Red Crescent Societies (IFRC), Acasus, and UNICEF. Gavi is working with IFRC to provide integrated primary health care, including basic health interventions and COVID-19 prevention, mitigation, and case management, especially in fragile and conflict-affected areas. Gavi has successfully partnered with Acasus in Pakistan, Afghanistan, and the Democratic Republic of the Congo (DRC). Acasus supports countries by strengthening programmatic leadership, management, and coordination; Acasus and Gavi also help countries develop dashboards to monitor program performance with a particular focus on inequity. UNICEF is working in Afghanistan to ensure that vaccines are properly delivered and co-administered with a range of other services, such as combining multi-antigen campaigns with nutritional support in targeted low-coverage districts. The overall aim of these partnerships is to provide a range of services in which immunization is included, she added.

Strategic Political Engagement

Gupta noted that Gavi has maintained constant dialogue with political leadership in six pivotal Gavi-supported countries that are home to 65 percent of zero-dose children: Nigeria (20 percent), India (18 percent), Pakistan (9 percent), the DRC (6 percent), Indonesia (6 percent), and Ethiopia (5

percent).⁵ Gavi segments countries into tiers based on their immunization rates, she added. The first tier consists of 10 large countries that are home to more than 75 percent of underimmunized and zero-dose children. Tier two consists of 10 countries that are fragile and have immunization-related challenges that are complicated by issues such as political instability or conflict. This group includes countries like the Central African Republic, Haiti, and Somalia, which require focused technical assistance from partners.⁶ These two tiers are referred to as pivotal countries, Gupta explained. Gavi has worked to elevate immunization dialogue to the highest levels of government in these pivotal Gavi-supported countries, and it has invested in political will to ensure that immunization is a top priority among these nations' prime ministers, financial ministers, and health ministers. This approach has been fruitful, she said, as immunization outcomes in these tier one countries have begun to improve.

Addressing Gender Barriers

Gender-related barriers have become an increasing area of focus for Gavi owing to the inextricable link between inequity and gender, said Gupta. In aggregate terms at the global level, boys and girls have equal access to immunization, but caregivers themselves face gender-related barriers to accessing vaccines. However, there are interventions aimed at alleviating these gender-related barriers that have been shown to improve immunization coverage. For instance, Senegal made adjustments to its immunization services (such as extending clinic hours or even simply relocating vaccination sites) to address the needs of caregivers, most of whom are women in Gavi-supported countries. These adjustments included weekend and late-night immunization sessions, vaccination at key transport hubs, and advocacy from key leaders, administrative personnel, religious leaders, and community leaders. These adjustments contributed to an increase in national DTP dose 3 coverage from 86 percent in 2018 to 93 percent in 2019.

Using Multiple Methods to Improve Coverage and Equity

Gavi strives to use all of its methods to improve vaccine coverage and equity, said Gupta. For example, in the DRC, a subnational approach was used, focusing on nine provinces. Political will was rallied through Gavi's sustained engagement with policy makers. The supply chain was improved

⁵ These data are likely internal and unpublished. The speaker cited no sources, and these figures could not be verified by the rapporteurs.

⁶ For more information on Gavi's Partners' Engagement Framework, see <https://www.gavi.org/news/media-room/engaging-partners-success> (accessed March 2, 2021).

through cold chain expansion in partnership with UNICEF. To improve data systems, District Health Information Software 2 (DHIS2) was rolled out and the health management information system was strengthened in partnership with the University of Oslo, WHO, and The Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund).⁷ Community organizations were engaged to implement social mobilization programs in 20,000 villages in partnership with Sanru. Gavi spurred innovation by partnering with VillageReach to explore vaccine delivery by drones. Performance-based financing was secured through collaboration with the Global Fund, the World Bank, and the Global Finance Facility. Through this approach 15,000 children were reached in Mongala province, 5,000 in Tshuapa province, and 55,000 in Kinshasa province. Gupta explained that this strategy has yielded good results, and innovative approaches to real-time data collection have allowed Gavi to track how many children were vaccinated as a result of these efforts.

Halting the COVID-19 Pandemic Requires Equitable Access to Vaccines

Gupta emphasized that ensuring equitable access to vaccines through a global, coordinated approach will help to halt the COVID-19 pandemic. To that end, WHO, the Coalition for Epidemic Preparedness Innovations (CEPI), and Gavi are co-leading the COVAX facility, a global pooled procurement mechanism designed to help countries obtain vaccines by guaranteeing predictable demand to vaccine manufacturers. Its goal is to accelerate equitable access to appropriate, safe, and efficacious COVID-19 vaccines, and all countries are invited to participate in order to secure affordable access to COVID-19 vaccines—including the 92 low- and middle-income countries (LMICs) supported by Gavi. COVAX is a risk management tool that will assist certain countries that may not be able to secure vaccines otherwise. It incentivizes manufacturers to develop products and scale up their manufacturing capacities by assuring future vaccine procurement. It also offers an actively managed portfolio of vaccines. Through this effort, Gupta explained, Gavi aims to ensure that doses secured between 2020 and 2022 will be equitably distributed worldwide and that high-risk populations will be covered in all countries. If doses are sold to the highest bidder, she said, the wealthiest countries are likely to secure the bulk of forthcoming vaccine doses in a time of scarcity.

⁷ More information about DHIS2 is available at <https://www.dhis2.org> (accessed September 25, 2020).

REDUCING BARRIERS AND INCREASING VACCINE UPTAKE AMONG ADULTS

Presented by Litjen (L.J.) Tan, Immunization Action Coalition

Tan explored strategies to reduce barriers to vaccination and increase vaccination among adults. He discussed the effects of COVID-19 on adult immunization, other factors associated with low vaccination coverage among adults, and strategies for improving adult immunization rates.

Burden of Vaccine-Preventable Disease Among Adults in the United States

Tan began with an overview of the vaccine-preventable disease burden among U.S. adults. Because the United States has well-developed pediatric and adolescent immunization programs, the burden of vaccine-preventable disease is primarily among adults. He noted that cases of invasive pneumococcal disease, influenza, pertussis, hepatitis B, zoster, and measles make up much of this burden:

- 2015: A multistate outbreak of measles linked to California, with 55 percent of infections occurring in adults aged 20 years or older (Clemmons et al., 2015)
- 2016: 21,600 new hepatitis B infections⁸
- 2018: 31,400 cases of invasive pneumococcal disease that caused 3,480 deaths, 91 percent of which occurred in individuals aged 50 years or older^{9,10}
- 2018: 3,322 acute cases of hepatitis B
- 2019: 15,662 pertussis cases with 3,736 cases among adults aged 20 years or older¹¹
- October 1, 2019, through April 4, 2020: 24,000 to 62,000 recorded influenza deaths with approximately 90 percent of cases occurring among adults aged 65 years or older¹²
- Reported herpes zoster cases reach approximately 1 million each year (Harpaz et al., 2008)

⁸ More information about hepatitis surveillance is available at <https://www.cdc.gov/hepatitis/statistics/2018surveillance/HepB.htm> (accessed September 28, 2020).

⁹ Each year, 649 per 100,000 patients are hospitalized with community-acquired pneumonia, and the mortality rate among these cases is 6.5 percent (Ramirez et al., 2017).

¹⁰ For more information on *Streptococcus pneumoniae* surveillance, see <https://www.cdc.gov/abcs/reports-findings/surv-reports.html> (accessed May 20, 2021).

¹¹ More information about pertussis surveillance is available at <https://www.cdc.gov/pertussis/downloads/pertuss-surv-report-2019-508.pdf> (accessed September 28, 2020).

¹² More information about the 2019–2020 U.S. flu season estimates is available at <https://www.cdc.gov/flu/about/burden/preliminary-in-season-estimates.htm> (accessed September 28, 2020).

Tan said that vaccine-preventable disease in adults is not highly prioritized. For instance, a 2015 measles outbreak that began in Disneyland was the focus of much media attention, yet little attention was paid to the fact that 55 percent of infections from that outbreak occurred in adults aged 20 years or older. This indicates the need to build awareness of the burden of vaccine-preventable disease in adults and of evidence-based guidance on these diseases from WHO and the U.S. Advisory Committee on Immunization Practices (ACIP). Tan presented the estimated costs and number of cases of four vaccine-preventable diseases in 2013, which totaled more than \$15 billion in estimated medical and indirect costs (see Table 3-2). He added that the cost of vaccine-preventable diseases in persons aged 50–64 would add an additional \$11.2 billion to this estimate.

Adult Immunization Coverage Rates in the United States

Adult populations in the United States remain undervaccinated despite the known consequences of undervaccination in terms of cost, mortality, and morbidity, said Tan. He presented adult immunization coverage rates from U.S. Centers for Disease Control and Prevention (CDC) National Health Interview Surveys conducted between 2014 and 2017, comparing reported immunization coverage with Healthy People 2020 immunization targets.¹³ During this period, immunization coverage for pneumococcus for individuals aged 65 years or older increased from approximately 60 percent to nearly 70 percent, falling short of the targeted 90 percent coverage. Similarly, pneumococcal immunization coverage for high-risk individuals (those with an

TABLE 3-2 Cost Burden of Four Adult Vaccine-Preventable Diseases in Persons Older Than 65 (United States, 2013)

Vaccine-Preventable Disease	Estimated Number of Cases	Estimated Costs, Medical and Indirect (millions, \$)
Influenza	4,019,759	8,312.8
Pneumococcal	440,187	3,787.1
Zoster ^a	555,989	3,017.4
Pertussis	207,241	212.5
Total		\$15,329.8

^a Herpes zoster is commonly known as shingles; see <https://www.cdc.gov/vaccines/vpd/shingles/index.html> (accessed December 18, 2020).
SOURCES: Tan presentation, August 17, 2020; McLaughlin et al., 2015.

¹³ More information about vaccination coverage among adults is available at <https://www.cdc.gov/vaccines/imz-managers/coverage/adultvaxview/pubs-resources/NHIS-2017.html> (accessed September 29, 2020).

increased likelihood of severe consequences from infection) aged 19–64 years fluctuated between 20–25 percent, falling short of the 60 percent target. However, immunization coverage for zoster increased from approximately 27 percent to 33 percent during this period, exceeding the coverage target of 30 percent for 2015–2017. Tan also presented data on seasonal influenza vaccination coverage from the 2015–2019 influenza seasons (see Table 3-3). Influenza vaccination is fairly low among adults in the United States—even among high-risk groups—despite recommendations that any individual aged 6 months or older receive the vaccination annually.¹⁴

Effect of the COVID-19 Pandemic on Adult Immunization

Tan noted that the immunization rates in the United States have declined during the COVID-19 pandemic for all vaccines and across all risk and age groups, not just pediatric vaccines. For instance, herpes zoster vaccination declined by 67 percent and use of the 13-valent pneumococcal conjugate vaccine at U.S. Department of Veterans Affairs facilities decreased by 88 percent.¹⁵ Regional variability in the number of COVID-19 cases has affected vaccine-seeking behavior disparately, with regional declines in

TABLE 3-3 Influenza Vaccination Coverage Among Adults (United States, 2015–2019)

Group	2015–2016 (%)	2016–2017 (%)	2017–2018 (%)	2018–2019 (%)
Persons aged ≥ 18 years	41.7*	43.3*	37.1*	45.3*
Persons aged 18–49 years, all	32.7	33.7	26.9*	34.9*
Persons aged 18–49 years, high risk	39.5	39.3	31.3*	40.4
Persons aged 50–64 years	43.6*	45.4*	39.7*	47.3*
Persons aged ≥ 65 years	63.4*	65.3*	59.6*	68.1*

* = Statistically significant declines/increases from the previous season ($p < 0.05$).
SOURCES: Tan presentation, August 17, 2020; <https://www.cdc.gov/flu/fluview/index.html> (accessed May 20, 2021).

¹⁴ More information about influenza vaccination coverage is available at <https://www.cdc.gov/flu/fluview/index.htm> (accessed September 29, 2020).
¹⁵ More information about the effect of COVID-19 on adult immunization coverage rates is available at <https://www.izsummitpartners.org/2020-naais/covid-impact-on-adult-imm-and-flu-plans> (accessed September 29, 2020).

vaccination coverage being linked to regional increases in infections. Tan suggested that localized planning may help to address these unique situations and variations in timing. Routine immunization rates are recovering but still lagging behind pre-pandemic levels for children. Recovery for adult immunization lags behind that for children. Moreover, at the time of this workshop, there have been no catch-up immunization efforts for either pediatric or adult populations and many individuals remain underimmunized because of the impacts of the pandemic. The pandemic also caused a significant decline in wellness visits for adults of all ages that have not yet recovered to pre-pandemic levels. Ambulatory care visits plummeted during the COVID-19 pandemic, and they remain 33 percent below pre-pandemic levels. Tan suggested that dispelling fears about exposure to COVID-19 in health care facilities could help encourage the public to return to their health care providers and mitigate the declines in vaccination among both adults and children. He added that telehealth—which has been implemented increasingly in the United States throughout the COVID-19 pandemic—could provide a platform that reassures the public they can safely use other health services.

Factors Associated with Low Vaccination Coverage Among Adults

Tan described three categories of factors that contribute to low vaccination among adults: patient factors, provider factors, and system factors. Unlike pediatric patients, many adult patients do not have a regular health care provider or only see medical specialists, but it is regular health care providers who routinely remind and advise adult patients about immunization. Patients also may not have convenient access to vaccination services and can often face competing social and economic demands. In the United States, many patients aged 18–64 years are underinsured and may not have the means to cover the costs of vaccines. While pediatric providers have well-established visit schedules that serve as a platform for routine immunization, adults tend not to use preventive health services. This is related to provider factors that contribute to low vaccination coverage. Because health care providers most frequently see adult patients when they are seeking care for acute health issues, reactive care often competes with preventive services, such as recommending and reminding patients about immunizations. System factors that contribute to low vaccination rates among adults include employment, qualifications required for administering vaccines, and government regulations about vaccine delivery. Tan opined that changing these system factors may be the easiest way to realize quick improvements in vaccination coverage. Finally, he pointed out that the complex adult vaccination schedule makes it difficult for some patients and providers to understand which vaccines are needed or when to recommend certain vaccines.

Confidence Barriers May Limit Demand for COVID-19 Vaccines

Vaccine hesitancy is not typically considered to be a contributing factor to low vaccination coverage among adults, said Tan. However, the trend of increasing vaccine hesitancy in the United States may limit the demand for vaccines in the future, particularly for forthcoming COVID-19 vaccines. Polling data from 2020 indicated that only half of all Americans would be willing to receive a COVID-19 vaccine if it became available (Schoch-Spana et al., 2020). Other polls have found that vaccine hesitancy and vaccine mistrust is greater among African American respondents than among Hispanic and white respondents.¹⁶ Overall, 49 percent of adult respondents said they plan to get a vaccine against COVID-19 when it becomes available. The affirmative response was more common among adults aged 60 years or older (67 percent) than younger adults (40 percent) and more common among white adults (56 percent) than Hispanic adults (37 percent) or African American adults (25 percent) (Neergaard and Fingerhut, 2020).

The most common rationale for accepting the vaccine was that individuals wanted to protect themselves or their families; other rationales included reductions of various hardships (e.g., illness, morbidity, death, isolation of physical distancing, disruption of economic activities). The primary reason cited for vaccine refusal was concern about vaccine side effects. Other concerns included institutional mistrust (e.g., mistrust of vaccine manufacturers, regulating agencies, public health authorities), concerns about contracting COVID-19 through the vaccine, lack of concern about the seriousness of the disease, and access issues, including concerns about affordability, ease of access, and safety of access. These concerns demonstrate the value of communication to reassure the public that the rapid development of vaccines is not being pursued at the expense of safety or efficacy, said Tan. Furthermore, these findings may indicate increasing rates of vaccine hesitancy among adults toward vaccines in general, because the concerns about COVID-19 vaccines cited by college-age respondents overlap with commonly cited myths and concerns about influenza vaccines (Ryan et al., 2019).

Strategies for Improving Adult Immunization Rates

Tan discussed a variety of strategies that are known to improve adult immunization rates, including enhancing access to vaccines, increasing community demand for vaccines, leveraging health care providers, and engaging health care systems. Enhancing access to vaccines is known to

¹⁶ More information about COVID-19 vaccine polling is available at <https://apnorc.org/projects/expectations-for-a-covid-19-vaccine> (accessed October 1, 2020) and <https://www.newsweek.com/will-black-americans-fear-vaccine-more-covid-19-opinion-1516087> (accessed October 1, 2020).

improve immunization rates, and it can be accomplished by introducing innovative access points and eliminating vaccine costs for patients.¹⁷ Community demand for vaccines can be increased by calling patients directly to remind them about vaccinations and using family incentives to encourage vaccination. For instance, some insurance plans offer coupons or health club memberships as rewards for families that get vaccinated. Tan emphasized the value of leveraging health care providers, explaining that concise, consistent, confident, and presumptive recommendations from health care providers are often effective for increasing vaccine acceptance. Finally, system-based changes can be implemented to increase vaccine coverage, including provider reminders, provider assessment and feedback, standing orders, and worksite interventions with onsite, reduced cost, and actively promoted influenza vaccinations for health care personnel. For example, provider reminders might be generated through the linking of electronic patient records to immunization registries.

Tan presented evidence from a meta-analysis of interventions to increase adult immunization uptake and cancer screening services (Stone et al., 2002). The analysis found the following interventions improved the odds ratio (OR) for use of immunization and cancer screening services among adults:

- Patient education (OR = 1.3)¹⁸
- Patient reminders (OR = 2.5)
- Patient financial incentives (OR = 3.4)
- Provider education (OR = 3.2)
- Provider reminders (OR = 3.8)
- Organizational changes, such as standing orders and separate clinics devoted to prevention (OR = 16.0)

Tan pointed out that each intervention improved adult vaccination; however, the OR for organizational changes was greater than the ORs of the other interventions (Stone et al., 2002), meaning that strategies like standing orders and vaccine-devoted clinics had the strongest positive effect on adult vaccine uptake.

Adult Vaccination During the COVID-19 Pandemic and Beyond

The COVID-19 pandemic has provided an opportunity to establish or improve existing infrastructure for vaccinating adults, said Tan. If done well,

¹⁷ More information about vaccination programs is available at <https://www.thecommunityguide.org/topic/vaccination> (accessed October 1, 2020).

¹⁸ Odds ratio in comparison to usual care or control group, adjusted for all remaining interventions.

such infrastructure improvements could result in durable progress in adult uptake of routine vaccinations. For instance, providers and health systems could send unified and coordinated messages about vaccination, engaging multiple stakeholders and leveraging the trusted voices and recommendations of health care providers. Such communication strategies may improve seasonal influenza vaccination and other routine adult vaccinations. Providers continue to be a trusted voice, he said, and they can play a valuable role in overcoming immunization barriers related to awareness, vaccine hesitancy, and simple logistics.

Tan advocated for innovative approaches to increasing vaccine access. Examples might include new delivery tactics, such as drive-through clinics, which have been successfully implemented for diagnostic testing during the COVID-19 pandemic. Many valuable lessons have been learned about health care delivery during COVID-19, and best practices from these experiences can be derived, shared, and expanded in order to better address the challenges of the pandemic, combat health care inequalities, and improve vaccine accessibility. Tan suggested that providers' compensation ought to be commensurate with efforts to mitigate the COVID-19 pandemic and the costs of innovation.

With the Northern Hemisphere's 2020 influenza season in mind, Tan highlighted the importance of the use of hashtags such as #takefluoffthetable and #avoidthetwindemic on social media. These movements will set the stage and prepare needed infrastructure for vaccination efforts in response to the COVID-19 pandemic.¹⁹ He proposed that influenza vaccination efforts remain in full force throughout 2020 and into 2021—until every dose is administered—thus extending the influenza vaccination season from August into January with appropriate clinical judgment.

National Vaccine Advisory Committee Standards for Adult Immunization Practice

The United States has a standard of care for adult immunization practice established by the National Vaccine Advisory Committee (NVAC).²⁰ Tan emphasized that this standard calls for more than merely advising patients to get needed vaccines—providers should follow up with patients about vac-

¹⁹ The speed and progress of vaccine development for COVID-19 have exceeded general expectations from the time of the workshop in August 2020. FDA issued the first emergency use authorization for a vaccine against COVID-19 on December 11, 2020. See more at <https://www.fda.gov/news-events/press-announcements/fda-takes-key-action-fight-against-covid-19-issuing-emergency-use-authorization-first-covid-19> (accessed May 20, 2021).

²⁰ More information about the National Vaccine Advisory Committee's Standards for Adult Immunization is available at <https://www.cdc.gov/vaccines/hcp/adults/for-practice/standards/index.html> (accessed October 5, 2020).

cines at every clinical encounter. To advance a paradigm shift in adult immunization, the NVAC standard calls for all health care providers (including non-vaccinating providers) to take four steps when they see an adult patient:

1. Assess immunization status of the patient at every clinical encounter.
2. Strongly recommend vaccines that the patient needs.
3. Administer vaccines at the same visit or refer the patient to a vaccine provider.
4. Document vaccines received by the patient.

Tan emphasized that this four-step standard of care is based on existing knowledge of the barriers to vaccination and established best practices for combating them. The problem is not a failure of understanding the problem; it is a failure of properly implementing proven solutions in the health care system.

USING MOBILE HEALTH INTERVENTIONS TO IMPROVE VACCINATION COVERAGE

Presented by Momin Kazi, Aga Khan University

Kazi described how mobile health (mHealth) interventions can help to improve vaccination coverage by addressing barriers to immunization and using geospatial mapping to follow disease outbreaks. He also explored challenges related to the use of mHealth interventions. He remarked that the implementation of policies intended to slow the COVID-19 pandemic have collaterally halted preexisting mass immunization efforts, regardless of a country's income (Hoffman and Maclean, 2020). Lack of adherence to childhood vaccination schedules also negatively affects vaccination coverage, he added (Lighter, 2019). Text messages are sometimes considered “the magic pill” for addressing these types of challenges. However, although automated mobile messages have shown effectiveness at improving vaccination coverage, as demonstrated in Pakistan's Sindh province,²¹ there are drawbacks to the use of such interventions.

Using Mobile Phones for mHealth Interventions

Kazi suggested that mHealth interventions aimed at increasing vaccine coverage may be most effective if they are compatible with non-smartphones

²¹ More information about automated mobile messages increasing vaccine coverage is available at <https://www.thenews.com.pk/print/524460-automated-text-voice-messages-increase-vaccine-coverage-in-sindh-s-under-served-areas-by-26pc> (accessed October 5, 2020).

to increase accessibility (Kazi et al., 2018). Even though mobile phone coverage has rapidly expanded in recent years,²² smartphone access has not expanded as rapidly in low- and middle-income regions of Asia when compared to wealthier regions, Europe, or the United States. Non-smartphones still outnumber smartphones in some Asian nations (e.g., India, Indonesia, the Philippines, and Thailand),²³ with less than one-third of the population using smartphones.

Because mobile usage across the world is variable, Kazi suggested considering people's preferred methods for text communication when determining an intervention. Kazi cited 2018 data from Textrequest Reports, claiming that there are 7.7 billion mobile phone service subscriptions globally.²⁴ In 2018, 8.5 billion person-to-person messages were sent via short message service (SMS) each day, and each mobile phone exchanged an average 32 SMS messages per day. He added that volumes on messaging apps are even larger. If planning to implement a digital health-based intervention, such as mHealth, Kazi suggested first considering the program's basic requirements, such as:

- Mobile network accessibility
 - Internet access
 - Mobile phone coverage
- Population access to mobile networks
 - Mobile network usage
 - Literacy
 - Technological savvy
- Availability of electricity for timely charging of mobile phones
- Device security
 - Risk of theft

In addition to technological requirements, Kazi pointed out some important considerations regarding infrastructure and the use of applications. Implementers will likely need to adhere to various regulations and maintain access to some gateway or portal through which they can view and monitor intervention data.

²² More information about global mobile phone coverage is available at https://www.brookings.edu/wp-content/uploads/2019/04/20190410_futuredevelopment_Mobile_owner_ship_2018.jpg (accessed October 5, 2020).

²³ More information about smartphone penetration is available at <https://www.nielsen.com/bd/en/insights/article/2013/the-asian-mobile-consumer-decoded> (accessed October 5, 2020).

²⁴ More information about mobile phone subscriptions worldwide is available at <https://www.statista.com/statistics/262950/global-mobile-subscriptions-since-1993> (accessed April 2, 2021).

Using Automated Messages to Address Barriers to Immunization

Kazi described the use of automated messages in addressing barriers to immunization. These messages can be sent via messaging apps, SMS, and as automated calls; the content is typically a reminder, educational message, or interactive message. Reminder messages may inform the recipient that their child is due for vaccination on a particular scheduled date. Educational messages may inform the recipient that their child's scheduled immunization will protect them against certain diseases (e.g., polio, whooping cough, diphtheria, measles, pneumonia, tuberculosis). Interactive messages may remind the recipient of a scheduled vaccine or checkup and prompt the recipient to send a response from a set of programmed options.

Kazi emphasized that these automated messages can be tailored to address specific barriers to immunization such as vaccine hesitancy, lack of knowledge, forgotten appointments, lack of trust, adverse effects, and religious or social barriers (Kazi et al., 2018). One systematic review of 12 studies—9 of which were conducted in the United States and 3 in LMICs—found modest evidence that messages sent via digital push technologies could improve vaccine uptake and series completion (Kazi et al., 2019). In this review, reminders and educational messages were used to promote the uptake of a wide range of vaccines, including all childhood vaccines; measles, mumps, and rubella (MMR); human papillomavirus (HPV); influenza; measles containing vaccine dose 4 (MCV4) or DTP; and pneumococcal.

According to Kazi, another review evaluated 21 studies, including 14 studies conducted in the United States and 7 studies conducted in LMICs. The studies evaluated the use of both one-way and two-way SMS reminders to promote coverage for a variety of vaccines, including all childhood vaccinations, HPV, MMR, influenza, MCV, DTP, and varicella. Researchers found that all the messages sent via SMS and automated calls increased vaccine uptake compared to the control arm—especially messages involving adolescent vaccines—demonstrating the potential for mobile phone-based interventions to improve immunization coverage for children and adolescents, said Kazi.

A 2020 systematic review examined 25 unique mobile applications designed to improve vaccine coverage. The review evaluated the applications for cost-effectiveness, usability, acceptability, participant perception, and vaccination outcomes (de Cock et al., 2020). The review comprised 28 studies, including pre-post studies, cross-sectional surveys, longitudinal studies, randomized controlled trials, qualitative studies, economic studies, and interrupted time series studies. Out of nine studies that evaluated vaccination uptake, four found significant improvement in vaccination coverage. Out of 10 studies that evaluated the effect of vaccination apps on knowledge and learning, 4 showed statistically significant improvements. He pointed out that

the quality of the 28 studies was moderate to poor, with many aspects of the studies' methodologies being unclear to the reviewers. Thus, further work is needed to develop new methods of evaluating these technologies, he added.

Kazi described additional studies that investigated the use of SMS interventions as a monitoring strategy in vaccination campaigns. In one pilot study, Kazi and his colleagues used automated SMS messages to monitor polio supplementary immunization (Kazi et al., 2014). To look at the role of SMS two-way messages for monitoring and supplementing immunization activity for house-to-house polio immunizations, they collected demographic and surveillance data and conducted a baseline survey in three towns in Karachi, Pakistan. Interactive messages in Urdu were sent to the households asking whether the vaccine had reached the household and whether the child had been vaccinated. The coverage data collected from responses to these messages were compared to coverage data generated from phone calls and National Quality Assurance Standards, which is WHO's preferred technique for household monitoring in the field. Kazi reported the coverage data from all sources were found to be comparable. Furthermore, the monitoring method used in the pilot study allowed for additional data collection, including geographic coordinates that could be used to generate vaccination density maps. Although this technique for remotely monitoring vaccination coverage via SMS messaging is valuable, Kazi cautioned that reminders sent via SMS messages may not be sufficient to guarantee improved immunization coverage. For instance, the technique used in this study did not allow researchers to collect vaccination data for all children in the household.

In another study, Kazi and colleagues conducted a randomized controlled trial on the effect of mobile phone text message reminders on routine immunization uptake in Pakistan (Kazi et al., 2018). They sent one-way reminder messages to participants on the expected week of vaccinations at weeks 6, 10, and 14. Results showed a 5 percent increase in immunization coverage for those receiving SMS messages when compared to the control arm. Both the intention-to-treat and per-protocol analyses showed higher coverage for each visit, but only the routine immunization coverage scheduled at 6 weeks was statistically significant. Furthermore, they found that 94 percent of participants had a mobile phone in their household and 99 percent of participants were comfortable using text messages. This study concluded that simple, automated, one-way SMS reminders in local languages may be feasible for improving routine vaccination coverage. However, it was not clear whether SMS reminders alone are sufficient to alter parental attitudes and behavior. Studies designed with higher statistical power are needed to compare the effectiveness of various types of messaging with various forms of content, Kazi noted. He added that further investigation is needed into the perceptions and barriers associated with immunization in local settings that can affect the implementation of SMS-based interventions.

Based on experiences from the previous studies, Kazi and his colleagues conducted another study investigating the use of SMS messages in improving vaccine coverage among children in urban and rural districts of Pakistan. The mixed-method study began with qualitative interviews and enrollment of children aged 0–2 weeks. The intervention comprised a sequence of weekly immunization messages.²⁵ The study had four intervention arms: one-way SMS messages, two-way SMS messages, one-way automated phone calls, and two-way automated phone calls (i.e., interactive voice recordings). Each week, messages were sent to participants in their chosen language.²⁶ These messages were rigorously designed to address the barriers to immunization identified during qualitative interviews, and were also adapted based on families' reported perceptions of vaccination and daily life challenges. Barriers revealed through qualitative interviews included forgotten due dates, lack of awareness, lack of socioreligious buy-in, distrust, and concerns about adverse effects. Kazi reported on the demographic findings of the study: 79.1 percent of participants had access to a simple function phone; 54.5 percent of fathers and 13.8 percent of mothers owned a mobile phone; 99 percent of participants were comfortable using SMS; and 50 percent of mothers and 38.4 percent of fathers had no formal education. The intervention used in this study showed a significant improvement in vaccination coverage, said Kazi. The greatest improvement was achieved by the interactive voice recording arm of the study, which showed a 26 percent improvement in vaccination coverage compared to the control arm. One technical challenge identified by the researchers was that a concerning number of families did not receive the intervention messages. Still, Kazi suggested that this intervention be scaled up using interactive voice recordings that are tailored according to identified barriers to immunization.

Using Geospatial Mapping to Follow Outbreaks

Kazi discussed the role of geospatial maps in improving vaccination coverage. Such a technique was used to investigate an outbreak of ceftriaxone-resistant *Salmonella enterica* serotype typhi in Hyderabad, Pakistan (Qamar et al., 2018). In this case, geospatial mapping data helped research-

²⁵ The intervention messages included general immunization education, education about adverse effects of immunization, education about religious immunization concerns, immunization reminders when participants' children reached ages 6 weeks, 10 weeks, and 14 weeks, and combination messages.

²⁶ Participants' language of choice was assessed during qualitative interviews, and these interviews were also used to select appropriate background music and dialogue for automated calls. Languages used in the study included English, Roman Urdu, Urdu, Roman Sindhi, and Sindhi. Forms of Urdu were often preferred at urban sites, while forms of Sindhi were often preferred at rural sites.

ers understand the burden of extensively drug-resistant typhoid in various areas throughout Pakistan, including Karachi. These maps have also been used to identify opportunities for catch-up vaccination and to strategize about DTP vaccination efforts.

Challenges in the Use of mHealth Interventions to Increase Vaccination Uptake

Kazi discussed several challenges related to the use of mHealth interventions for increasing vaccination uptake. Phone access and ownership is central to the success of these interventions, particularly in LMICs. Importantly, phone access and ownership vary between females and males, within family structures (i.e., fathers' access versus mothers' access to phones), and within communities and villages. Literacy is another important concern, as low literacy rates can reduce the effectiveness of mHealth interventions reliant on text messages. Thus, care should be taken in intervention design to identify and use the appropriate method of best understanding in each setting. Using participants' preferred language, or pictorial aids, can help address issues of literacy and language comprehension. Kazi reiterated the importance of tailoring messages to address specifically identified barriers as well as carefully selecting the types of messages used in mHealth interventions. Availability of appropriate infrastructure and lack of technological savvy may also pose challenges to mHealth interventions, he added. Local infrastructure needs to be able to sustain the communication infrastructure demands of these interventions so participants can send and receive the requisite messages to fully partake in interventions. These interventions also require that participants have sufficient ability to operate their mobile phones and smartphones. Lastly, he pointed out that in settings where mobile services, vaccination services, and other health care providers are unavailable, mHealth interventions cannot be effectively implemented. He characterized these situations as missed opportunities.

Given the need for well-planned, personalized, community-based, knowledge-translation interventions, Kazi suggested that mHealth should be scaled up at the program level. He proposed that these programs be barrier based and connected with digital immunization registries to engage directly with caregivers throughout routine immunization programs. These interventions may also be adapted to artificial intelligence and machine learning models. He acknowledged that scale up is complex and requires extensive stakeholder engagement, adding that considering the "human factors" is invaluable during the scale-up process. Lastly, Kazi highlighted the importance of both implementation and evaluation for the success of digital health interventions. Evaluation of efficacy is valuable, he said, but evaluation of the "why and how" is of the utmost importance.

THE ROLE OF COMMUNITY-BASED PHARMACY INTERVENTIONS IN INCREASING VACCINE ACCESS

Presented by Jeff Goad, Chapman University School of Pharmacy

Goad discussed an approach to pharmacy-based vaccination that could potentially be implemented in various settings throughout the world. This approach requires only access, expertise, and operational efficiency to facilitate the delivery of vaccines in a community. He began with an overview of pharmacists' involvement in vaccination efforts in the United States. Increased pharmacy involvement in vaccination began in 1993, when the U.S. Department of Health and Human Services asked the American Pharmacists Association (APhA) to define the role of pharmacists in administering vaccines to adults.²⁷ Before 1996, fewer than 14 states had approved pharmacists to administer influenza vaccinations, and few pharmacists were trained to administer vaccines. In 1996, APhA created the Pharmacy-Based Immunization Training Program and by 2009 all states allowed pharmacists to administer influenza vaccines to adults. Goad explained that the 2009 influenza pandemic was the breaking point that spurred all states to partner with pharmacists to assist with vaccine administration. By 2020, pharmacists in 52 U.S. states and territories had been permitted to administer vaccines that cover influenza, meningococcus, tetanus/diphtheria/pertussis (Tdap), zoster, and pneumococcus, and currently 47 states allow pharmacists to administer any vaccine. Between 2007 and 2017, the number of U.S. pharmacists trained to administer vaccines increased from 40,000 to 320,000. Pharmacists are trained to administer vaccines through a national immunization training program recognized by CDC.

Goad invoked the concept of a “neighborhood of other providers,” adding that providers ought to “walk the walk and talk the talk” in terms of vaccination. He presented data on vaccination coverage among health care providers to underscore this point. Influenza vaccination rates among pharmacists has been documented since the 2012–2013 influenza season, and coverage among pharmacists has remained between approximately 85 percent and 91 percent since 2012.²⁸ Similarly, during the 2018–2019 influenza season, at least 90 percent of physicians, nurses, and nurse practitioners/physician assistants were vaccinated against influenza. Goad explained that the

²⁷ More information about the number of states authorizing pharmacists to administer influenza vaccine and the number of pharmacists trained to administer vaccines is available at https://www.pharmacist.com/sites/default/files/files/States_Authorizing_Pharmacists_vs_training_December_2017.pdf (accessed October 7, 2020).

²⁸ More information about influenza vaccination coverage among health care personnel is available at https://www.cdc.gov/flu/fluview/hcp-coverage_1819estimates.htm (accessed October 7, 2020).

pharmacy has become one of the primary places of influenza vaccination for adults, second only to the traditional vaccine distribution setting of doctor's offices.²⁹ Between 1998 and 2019, the percentage of adult influenza vaccine administered at pharmacies increased from 5 percent to 32.2 percent. Importantly, this increase in vaccination at pharmacies reflects improved access to vaccines and an expanded pool of vaccinated adults, rather than merely a shift in location of vaccine administration (Papastergiou et al., 2014).

Challenges in Pharmacy-Based Vaccination

While the expansion of pharmacy-based influenza vaccination has been successful overall, there have been some shortcomings, said Goad. For instance, in 2017 only 10.3 percent of recently pregnant women who received influenza vaccines had their vaccine administered at a pharmacy, drug store, supermarket, grocery store, or superstore.³⁰ Similarly, in 2017 only 7.4 percent of women who received Tdap vaccines had their vaccine administered at a pharmacy, drug store, supermarket, grocery store, or superstore.³¹ Goad pointed out that pharmacists are allowed to administer Tdap vaccinations in all U.S. states, but there is an apparent drop-off in pharmacy-based vaccination among pregnant women. This drop-off is likely related to perceptions and knowledge about the role and training of pharmacists, he said. Patients may be unaware that pharmacists are authorized and trained to administer vaccines other than influenza vaccines and that they are able to administer vaccines to pregnant women. Education efforts may help to address these challenges, he said.

In a study that investigated the role of pharmacy-based vaccination and extended hours of vaccination, Goad and colleagues conducted a retrospective database analysis (Goad et al., 2013). They looked at the number and proportion of vaccines administered by a large chain pharmacy during traditional clinic hours (i.e., weekdays between 9 a.m. and 6 p.m.) and off-clinic hours (i.e., early mornings, evenings, weekends, and federal holidays). The chain administered 6.2 million doses of vaccine between 2011 and 2012. Of those vaccinated, 69.5 percent received the vaccination during traditional clinic hours and 30.5 percent received the vaccination during off-clinic hours, with

²⁹ More information about general population vaccination coverage is available at <https://www.cdc.gov/flu/fluview/nifs-estimates-nov2018.htm> (accessed October 7, 2020).

³⁰ More information about influenza vaccination among pregnant women in the United States is available at <https://www.cdc.gov/vaccines/pregnancy/hcp-toolkit/pregnant-coverage-estimates.html> (accessed October 7, 2020).

³¹ More information about pregnant women and Tdap vaccination in 2017 is available at <https://www.cdc.gov/vaccines/imz-managers/coverage/adultvaxview/pubs-resources/tdap-report-2017.html> (accessed October 7, 2020).

10 percent in evenings.³² Of the vaccines administered by the pharmacy chain, 85 percent were influenza vaccines and 15 percent were routine vaccines, travel vaccines, or other vaccines. Goad commented on the surprising number of people choosing to vaccinate on federal holidays (around 182,000 people).

Goad discussed unexpected findings regarding age groups and after-hours vaccination rates. Of those vaccinated at the pharmacy chain, 46 percent were aged 65 years or older and 3.3 percent were aged 18 years or younger. During non-clinic hours however, 22 percent of those vaccinated were aged 65 or older while 51 percent were aged 18 years or younger. Goad suggested that this pharmacy may have met the needs of parents who wished to have their children vaccinated after work. Even though the group for children aged 18 years or younger comprised only 3.3 percent of all vaccinated individuals in the study, Goad interpreted their overrepresentation in the evening vaccination cohort as a possible opportunity to expand vaccine access during off-hours.

One way that pharmacy-based immunization has been promoted is through the creation of state-authorized providers, said Goad. In 18 states, pharmacists who have this designation are authorized to provide influenza vaccines without a prescription or any other protocol involving a physician.³³ Even with this designation, however, there are some variations based on age. State-authorized providers are only allowed to administer vaccinations to children above a certain age, which varies by state.³⁴ In these states, pharmacists' authority to administer vaccines comes from a statute, a state board of pharmacists, or public health regulations.

³² Goad reported that 10.19 percent of those vaccinated received their vaccination during the evening; 17.39 percent of those vaccinated received their vaccination during a weekend, and 2.92 percent of those vaccinated received their vaccination on a federal holiday.

³³ More information regarding state regulations about pharmacist-administered vaccines is available at <https://www.pharmacist.com/sites/default/files/files/practice/07-2020/pharmacist-administered-vaccines-june-2020.pdf> (accessed October 7, 2020).

³⁴ Goad explained that the age breaks in each state are set based on state-specific considerations. For instance, the age break in California is based on the CDC anatomic age break for vaccination for children. According to CDC, children aged ≥ 3 years may be vaccinated via the deltoid (versus the vastus lateralis). Accordingly, California authorizes pharmacists to vaccinate individuals aged ≥ 3 years. In Arkansas, New Hampshire, and New Mexico, pharmacists are authorized to vaccinate individuals of any age. In Virginia, pharmacists are authorized to vaccinate individuals aged ≥ 6 months. In Arizona and California, pharmacists are authorized to vaccinate individuals aged ≥ 3 years. In Idaho and Wisconsin, pharmacists are authorized to vaccinate individuals aged ≥ 6 years. In Louisiana, Maine, Oregon, Texas, and Wyoming, pharmacists are authorized to vaccinate individuals aged ≥ 7 years. In Maryland, pharmacists are authorized to vaccinate individuals aged ≥ 9 years. In Montana and South Carolina, pharmacists are authorized to vaccinate individuals aged ≥ 12 years. In South Dakota and West Virginia, pharmacists are authorized to vaccinate individuals aged ≥ 18 years.

The Case for Pharmacy-Based Immunization

Goad made a case for pharmacy-based immunization based on three factors: geographic distribution of pharmacies and pharmacists, the access to vaccines through pharmacies, and the training systems in place for pharmacist-administered vaccination.

First, pharmacies and pharmacists are common and accessible throughout large portions of the country. There are 88,181 pharmacies across the United States, around half of which are independent and half are corporate chains (Qato et al., 2017). Goad claimed that the country has more than 300,000 licensed pharmacists, making it one of the largest health care professions in the country after physicians and nurses; about half of all pharmacists work in community pharmacies.³⁵ Around 86 percent of the U.S. population lives within 5 miles of a pharmacy (NACDS, 2018). Some regions have fewer pharmacies per 10,000 population, especially on the West Coast where the majority of the population is concentrated in high-density metropolitan areas.

Second, pharmacy-based vaccines are more accessible. In support of his case, Goad added that all 50 U.S. states allow pharmacists to administer vaccines, and because pharmacies are typically open during off-clinic hours, they extend the hours available for vaccination.

Third, pharmacists are trained and qualified to administer vaccines. Schools of pharmacy are required to teach immunization as part of their curricula, ensuring that pharmacists have the requisite expertise to administer vaccines. Pharmacists can receive additional training about vaccination through a national, CDC-recognized training program, he added.

Potential for Pharmacy-Based Immunization in Response to Pandemics

Goad presented findings from a Monte Carlo simulation of an influenza pandemic to demonstrate the potential of pharmacy-based immunization as part of multimode vaccine delivery response (Bartsch et al., 2018). The simulation revealed that having multiple providers administering vaccinations reduces stress on any given system. In the simulation, when only clinics and physician offices were administering pandemic vaccines, the overall vaccination coverage was lower than when vaccines were administered through a combination of delivery modes, including large retail pharmacies, independent pharmacies, urgent care centers, clinics and physician offices, and hospitals. In a scenario in which only clinics and physician offices could provide vaccinations against a pandemic influenza, Goad suggested that the

³⁵ For more information on community pharmacies, see <https://www.bls.gov/ooh/healthcare/pharmacists.htm> (accessed December 17, 2020).

quality of routine care would also be reduced owing to the additional vaccination burden. The simulation confirmed the value of starting vaccination early in a pandemic and maximizing the immunization rate to maximize the benefits of immunization during a pandemic. In the simulation, using pharmacies to administer vaccines increased vaccine coverage by 33.7 percent, avoided up to 23.7 million symptomatic influenza cases, and realized a cost savings of up to \$2.8 billion to third-party payers and \$99 billion to society.

Goad discussed the 2009 H1N1 pandemic as an example of pharmacy-based vaccination. During the 2009 H1N1 pandemic, pharmacy-based vaccination was implemented relatively late. Still, between December 2009 and February 2010, CDC distributed 5 million doses of 2009 H1N1 vaccine to pharmacy chains. Ten percent of people in the United States who were vaccinated against that pandemic virus received their dose in a pharmacy (Koonin et al., 2011). Had pharmacy-based vaccination been implemented immediately, pharmacists would have likely administered an even greater proportion of vaccine doses during that pandemic, said Goad. He emphasized that this valuable lesson may inform pandemic responses in the future to ensure that all partners are used to deliver efficient, effective, and safe vaccines.

DISCUSSION

Applying the Zero-Dose Children Concept to Other Populations

MacDonald acknowledged the value and impact of the zero-dose concept in low-income countries and asked whether this model could work in middle- and high-income countries. Gupta pointed out that the zero-dose concept is still nascent, but it has value as a measure of vaccination coverage in LMICs such as Brazil, the Philippines, and South Africa where the number of under or unimmunized children is increasing. In high-income countries, it may also be worthwhile to measure zero-dose children because of the emerging trends of vaccine hesitancy and anti-vaccine sentiment. Thus, although the drivers of zero-dose children rates may vary, the measure itself could have value in any setting. She added that the zero-dose concept also demonstrates the need to proactively address stigmatization and compounded vulnerabilities. MacDonald asked whether the zero-dose concept can be applied to adult populations who have never received DTP/Tdap, pneumococcal vaccine, varicella vaccine, or influenza vaccine. She also proposed that these would-be zero-dose adults could be identified via geospatial mapping, similar to the techniques discussed by Kazi.

Tan commented that measuring zero-dose children in the United States could be problematic; for instance, selective dose skipping of pediatric immunizations may complicate the measurement process. However, it may be more feasible to use geospatial technology, zip code tracing, and geographic

information systems to identify adults who have not received immunizations. These technologies may help to reveal not only the location of underimmunized adults, but also possible underlying causes that should be addressed (e.g., socioeconomic barriers to vaccination). He pointed out the difficulties associated with addressing social determinants of health in the United States and hypothesized that applying the zero-dose concept to American adults could help to identify geographic areas with limited access to vaccines and preventive health—so-called vaccine deserts or preventive health deserts. He suggested that issues of vaccine trust may also be connected to the broader considerations related to the social determinants of health.

MacDonald remarked that Gavi has focused its efforts on childhood vaccines and HPV for school-aged children, but WHO has not focused on adult immunization in a commensurate way. She asked whether the zero-dose concept could be repurposed for adult immunization. Ann Lindstrand, Expanded Programme on Immunization coordinator at the Department of Immunization and Biologics at WHO, said that the concept could kick-start efforts to increase vaccine reach and access. It could also improve approaches to vaccination of adults as well as at-risk groups (e.g., older adults) that have complex challenges related to identification and monitoring. She added that the zero-dose concept is also appropriate for children in high-income countries, where there are many socioeconomically deprived children, children of undocumented migrants, and other children in marginalized populations who may not have received a single dose of any vaccine. She noted that whether targeting zero-dose children or adults, the same steps apply: map, find, listen, adapt, tailor, and respond with services. MacDonald suggested that those steps should be instilled in all health care professionals.

Role of Pharmacies in Immunization Delivery and Education

MacDonald pointed out that in the United States and other high-income countries, pharmacies are fairly accessible, and most individuals visit a pharmacy much more frequently than they visit a family physician. She asked how pharmacies could be used as vaccination delivery sites for forthcoming COVID-19 vaccines once they become widely accessible to adult populations. Goad noted that there are efforts already under way to address this question. With funding from a CDC grant, the California Department of Public Health is working on adapting the current model used for influenza vaccination. However, because of the novel protocols associated with the COVID-19 pandemic—such as the need for personal protective equipment (PPE) and other safety precautions—it is yet unclear whether pharmacies can transition to administering COVID-19 vaccinations while maintaining the same operational efficiencies and high throughputs they have been able to achieve with the seasonal influenza vaccine. Pharmacies are typically

located in retail locations near parking lots, in grocery stores, and in other spacious settings, so innovative approaches to vaccination and pharmacist deployment could be beneficial in the pandemic context. Furthermore, the increase in mail-order medication distribution has afforded pharmacists more time that can be spent on patient care programs. Goad maintained that pharmacists could play a major role in distributing forthcoming vaccines in 2021 by serving as the access point of convenience for both receiving and distributing vaccines.

McDonald asked about the potential role of pharmacies in providing immunization education as well as serving as vaccine delivery sites, given the frequency with which people tend to visit pharmacies. Goad noted that the role of pharmacists as educators has been explored not just for immunization education, but for other preventable diseases as well. A wide range of tools are available to pharmacists, including informative posters and targeted campaigns informed by databases. He pointed out that each time a person visits a pharmacy, it is a unique opportunity for the pharmacist to provide education. He suggested using data to target interventions, as well as using patients' frequent visits to afford pharmacists the opportunity to come out from behind the counters and interact with their patients.

Tan suggested using other health care delivery settings in addition to pharmacies. For instance, immunization efforts could use the ongoing shift in the United States and abroad toward larger, comprehensive health care systems. In addition to using business models as a driver, the case for investment in immunization could be made stronger by invoking the benefits of immunization in connection with chronic disease management and patient experience. Tan suggested implementing known strategies for expanding immunization coverage and other preventive and educational services. For instance, health systems could begin to recommend that patients visit their pharmacist, who can have systems in place to provide innovative access to immunizations and education. These systems will be especially relevant in addressing the ongoing COVID-19 pandemic, but they should also be sustained indefinitely. These systems can also reduce costs and introduce new pathways for care. For instance, in the future, patients may be able to begin their care with a telehealth visit, then be referred directly to an expanded access location such as a pharmacy.

Literacy and Vaccine Uptake in Low-Income Countries

MacDonald asked whether literacy is an issue connected to poor vaccine uptake in low-income countries. Lindstrand said that literacy plays a role in vaccination uptake, adding that oral communication between health care providers and parents must be conducted in an appropriate and respectful way. She added that if immunization strategies transition toward digital tools

and SMS messages, then literacy will certainly be a barrier. Strategies for sharing and discussing the value of vaccines should be tailored to a specific population based on the kind of information that needs to be conveyed. Gupta cited evidence on the connection between immunization uptake and literacy and compelling data to support the claim that maternal health literacy is independently associated with child vaccination (Johri et al., 2015). Gupta added that the connection between female literacy and immunization uptake in low-income settings is related to the fact that mothers are disproportionately bearing the burden of child care. One aspect of strategies for addressing gender-related barriers is to bring men into the conversation. Additional gender-related issues also need to be considered, such as the gender gap in access to mobile phones.³⁶ She cautioned that when targeting zero-dose children among the poorest of the poor, digital interventions may actually exacerbate underlying inequities.

Kazi said that literacy has been a hurdle in the studies he has conducted, particularly with regard to the use of text messages. In a study evaluating personalized text messages and automated calls for improving vaccine coverage among children in Pakistan, around 50 percent of fathers and 38.4 percent of mothers had received no formal education and the majority of illiterate participants lived in rural areas (Kazi et al., 2018). Pictorial messages or other messages personalized and tailored for such families may help to alleviate this barrier. For instance, when a message is sent to a husband or mother-in-law who then passes on the message to the participant—typically the mother of the child—that message can help bring about a change in vaccination choices.

This same notion applies to the issues of gender disparities, he noted. Fathers are often the only household member with access to a mobile phone. If health care workers counsel families appropriately and send messages to the household that address the issues raised by the household decision maker, then mobile phone-based interventions can change behavior despite gender disparities in access to mobile phones. Kazi suggested that the mobile phone-based techniques used to promote child vaccination in low-income countries could be used to promote vaccination among adults in high-income countries, especially for forthcoming COVID-19 vaccines. Because mobile phones are ubiquitous in high-income settings, messages can be personalized both in terms of identified barriers and in terms of the technologies used to deliver messages. MacDonald asked whether mobile phone-based interventions should send messages at a particular time of day. Kazi said that in his group's studies, participants were asked at which time they would like to

³⁶ More information about the mobile gender gap is available at <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2020/05/GSMA-The-Mobile-Gender-Gap-Report-2020.pdf> (accessed October 8, 2020).

receive messages during the baseline interview process. Although preferred times varied between rural and urban participants, around 70 percent of participants said that any time was acceptable. Some participants, especially in rural settings, preferred to receive messages during the evening. He speculated that the evening preference may reflect that the mobile phone is with the male member of the family during the day. If so, it may be the case that evening messages would be more effective because it would increase the likelihood that female family members might also see the messages.

Building Trust and Overcoming Racial and Ethnic Disparities in Immunization

Regarding the COVID-19 vaccination survey, MacDonald reiterated the finding that African American and Hispanic populations in the United States were found to be less willing to receive the vaccine. She asked Tan to elaborate on the survey participants (e.g., whether it was possible to determine geospatial location and identify first-generation immigrants—and their access to vaccination services). Tan replied that the survey did not capture whether participants were first-generation immigrants.³⁷ He said:

The Minority Quality Forum has conducted research about adult immunizations among African American communities which found that a majority of African Americans living in urban areas reside in one of 32 U.S. zipcodes that could potentially be used to geographically map racial disparities and target those populations with messaging that encourages them to visit a pharmacist and get vaccinated.^{38,39}

Cultural sensitivity is needed in considering the use of access points, such as community centers and places of worship, where trusted community voices can deliver messages about vaccinations. He suggested that mistrust of health care systems (especially government entities) among some demographic groups, specifically among the African American population, may be a barrier that could be addressed by community leadership engagement and culturally sensitive consideration of alternative access points.

³⁷ More information about COVID-19 vaccine polling is available at <https://apnorc.org/projects/expectations-for-a-covid-19-vaccine> (accessed October 1, 2020) and <https://www.newsweek.com/will-black-americans-fear-vaccine-more-covid-19-opinion-1516087> (accessed October 1, 2020).

³⁸ For more information on zip codes as tools for geographically targeting areas of poor vaccine coverage, see <https://link.springer.com/article/10.1007/s12325-020-01324-y> (accessed December 4, 2020).

³⁹ For more information on the National Minority Quality Forum's indices, see <https://www.nmqf.org> (accessed May 20, 2021).

MacDonald said that in low-income countries, buy-in from religious leaders and community leaders significantly improves uptake of vaccines and other health services. She highlighted the value of imbuing a sense of ownership in health care providers at the community level to mobilize them to address health issues in their own communities. To that end, she asked how pharmacies could play a role in promoting community-level ownership. Goad suggested two methods. Pharmacists are consistently ranked among the most trusted professions in terms of honesty and ethics;⁴⁰ however, much progress remains to be made to ensure that pharmacists better reflect the communities they serve. For example, pharmacies can hire technicians and clerks who live in the communities where pharmacies or clinics are located. This will bring patients and pharmacists closer together, and improve opportunities for basic education about vaccinations. He added that community pharmacies have made more progress than retail pharmacies in this respect.

Tan pointed out that policy regarding racial and ethnic disparities is set at the national level, but implementation happens at the local level. Geographic data can be used to identify those local health care providers who are falling short in implementing such national policies—not to highlight their failures, but to address gaps in implementation and give these providers the appropriate tools for outreach and communication. Tan suggested using political advocacy to help gain funding for local-level efforts. For example, immunization advocates could inform members of the U.S. House of Representatives of the low rates of vaccination among their African American or Hispanic constituents to galvanize both fiscal and policy support.

MacDonald noted that in 2004, UNICEF and WHO published guidance on working with religious leaders to build trust in immunizations (UNICEF, 2004). She asked whether any guidance efforts were under way to support engagement with trusted community members, specifically in communities in high-income countries with low immunization uptake. Lindstrand said that such guidance is not yet under development, but there are efforts under way to address misinformation related to the COVID-19 pandemic that may include leveraging trusted community voices. MacDonald said that religious leaders play an important role in promoting vaccines in communities around the world. Therefore, engaging with these trusted individuals could be an effective step for changing perceptions in vaccine-hesitant communities.

Gupta explained Gavi's philosophy that immunization programs must be locally developed and adapted. Furthermore, developing language and idioms that resonate with communities is critical. For instance, in Laos, the use of the languages of certain ethnic minorities is prohibited under national

⁴⁰ More information about Gallup's ranking of honesty and ethics in professions is available at <https://news.gallup.com/poll/274673/nurses-continue-rate-highest-honesty-ethics.aspx> (accessed October 8, 2020).

law. This creates a “problem of idiom” and gives rise to communication barriers that may need to be addressed through methods of visual communication. She noted that religious leaders have played important roles in Gavi’s strategies, such as efforts to fight polio in India and their work with an Uluma organization to address challenges related to halal restrictions in Indonesia. Religious leaders play an important role in most contexts, but the strategy used to engage religious leaders will vary according to the context, she added.

MacDonald remarked that Canada uses state immunization documents in 12 languages to account for the large population of new immigrants and refugees that arrives each year. Despite this attempt at bridging language gaps, it is likely these documents were translated without accounting for idiom and community mindsets. Tan replied that the Immunization Action Coalition translates documents as well; they currently offer documents in 27 languages, but they have not yet made an effort to ensure culturally competent communication. Culturally competent communication goes beyond merely the correct language, but includes a cultural understanding founded on knowledge of societal doctrines. For instance, in a collectivist society, collectivist language should be used. Alternatively, cultures that value individual independence, such as the Russian immigrant communities in the United States, may be more receptive to different styles of wording. He said that broadly, the vaccine advocacy community has not yet captured and applied this kind of knowledge to better engage with racial and ethnic minorities.

Reflections on Session 1

Heidi Larson, professor of anthropology and risk and decision science at the London School of Hygiene & Tropical Medicine and director of the Vaccine Confidence Project, provided her reflections on the first day of the workshop. She noted the importance of simultaneously considering issues related to both demand and access. COVID-19 has globally disrupted vaccines and public health, and has broadly impacted immunization rates and practices. While strong infrastructure, appropriate messaging, and education are needed to improve vaccine uptake, the often neglected role of personal values in immunization attitudes cannot afford to be ignored. The moral foundations of decision making and engagement with health care are often poorly integrated into public health and immunization efforts, where context-specific values such as care, fairness, loyalty, authority, purity, liberty, and a sense of self-agency should be considered. Larson said that diversity is another major issue that demands differentiated, context-specific strategies to unmask inequities (e.g., the COVID-19 pandemic’s disproportionate impact on marginalized groups).

Geospatial mapping has promise for enhancing the capacity to think locally, while advocacy, strategic political engagement, and new public–private partnerships could help to link local and national efforts. The COVID-19 pandemic has most severely impacted those adult populations in which vaccination rates were already low, which has revealed the inadequacy of efforts to address vaccine hesitancy among adults. She noted that the Sage Vaccine Hesitancy Working Group has identified several determinants of vaccine acceptance—including demand factors such as confidence, convenience, and complacency—and pointed out some complacency around the COVID-19 pandemic, with some groups believing that COVID-19 is not a serious concern.

Larson noted that mHealth interventions can play a valuable role in addressing certain barriers to vaccination, but the success of those interventions may hinge on underlying determinants such as infrastructure factors (e.g., access to the Internet, electricity, and mobile phones), gender barriers, intra-family power dynamics, timing of messaging, and synchronicity of interventions within other health system components. Moreover, mHealth interventions cannot be effectively deployed in settings where the corresponding health services are unavailable. Not only would such interventions be ineffective, they may be counterproductive and reduce public confidence.

Community engagement is foundational to promoting immunization and reducing vaccine hesitancy, said Larson. Pharmacists and religious leaders can be leveraged to improve education and vaccine acceptance in communities, but community engagement should be conducted with an appropriate awareness of context and societal doctrines. The response of religious leaders in the face of the COVID-19 pandemic has shown that religious leaders are receptive and willing to engage with public health; however, they should be consulted on the design of messaging to their communities, not merely asked to disseminate information. She suggested using the resourcefulness demonstrated by religious groups that have transitioned to online gatherings and other creative solutions to stay engaged and connected with their congregations. Additionally, COVID-19 vaccinations could be presented as an opportunity to resume in-person gatherings for worship, just as it is being presented as an opportunity to resume in-person work activities. In closing, Larson emphasized in an anecdote the need to collaborate with religious leaders as partners in planning for vaccination efforts, instead of just using them as a communication conduit. She quoted a Nigerian archbishop that she met during her immunization work with UNICEF, who pointed out how organizations like UNICEF “come to us for our megaphones; come to us for our pulpits. But what they don’t come to us for, as religious leaders, is our insights and understandings.”

4

Assessing Global and Local Drivers of Vaccine Hesitancy

The second session of the workshop focused on assessing global and local drivers of vaccine hesitancy, with the objectives of (1) examining trends in hesitant attitudes toward vaccination and the effect on declining immunization rates; (2) evaluating the complex determinants and drivers of vaccine uptake, including sociocultural factors that influence perceptions, attitudes, and behaviors toward vaccination; and (3) exploring methods to monitor and measure vaccine hesitancy to better address concerns and to sustain confidence in vaccination. Stefan Flasche, associate professor at the London School of Hygiene & Tropical Medicine, described the burden of vaccine-attributable severe dengue in the Philippines and the effect of dengue vaccination campaigns on the national immunization program. Julie Leask, professor at the University of Sydney, Australia, discussed measurements of behavior and social drivers of vaccination. Julie Bettinger, associate professor at the Vaccine Evaluation Center at The University of British Columbia, Canada, explored the drivers and spectrum of vaccine hesitancy. Noel Brewer, professor at the University of North Carolina at Chapel Hill, presented on the Increasing Vaccination Model. He discussed propositions and next steps for changing vaccination behavior. The session was moderated by Alison Bутtenheim from the University of Pennsylvania.

VACCINE-ATTRIBUTABLE SEVERE DENGUE IN THE PHILIPPINES AND THE IMPACT ON NATIONAL IMMUNIZATION PROGRAMS

Presented by Stefan Flasche, London School of Tropical Medicine & Hygiene

Flasche described the burden of vaccine-attributable severe dengue in the Philippines and the effect of mass vaccination with Dengvaxia—the first licensed dengue vaccine—on national immunization programs. He also made suggestions for approaching future coronavirus disease 2019 (COVID-19) vaccination efforts based on lessons learned from this case study in the Philippines.

Dengue and Dengvaxia

Dengue is a major global health priority, with 100–400 million annual infections worldwide.¹ Flasche said that many people with dengue require medical attention, with some developing severe symptoms including death (though this is relatively rare). The burden of dengue is growing rapidly due in part to the expanding range of the primary vector, the *Aedes aegypti* mosquito. Dengue has four serotypes. Typically, an infection with one serotype will trigger a pan-serotype immune response, providing short-lived immunity for about 6 months to 1 year; serotype-specific immunity can be longer lasting and even lifelong. The epidemiology of dengue is complicated by what is known as antibody-dependent enhancement of disease. That is, if a person has an initial infection with one serotype, a second infection with another serotype will be much more likely to result in severe disease owing to reactions among existing partial antibodies.

After decades of development, Dengvaxia (the first ever licensed dengue vaccine) showed efficacy against all serotypes in phase 3 clinical trials conducted with more than 30,000 participants across Latin America and Asia (Flasche et al., 2016). Flasche noted that the size of these trials was sufficient to address the primary outcome; all serotypes of clinical dengue were reduced by 50–70 percent among those who were vaccinated, including those with and without prior infection. During the follow-up phase in the third year of the trial, a potential safety signal was identified. In the control group of unvaccinated children aged 2–5 years, there was 1 case of hospitalized dengue while there were 15 cases among those vaccinated. Flasche noted that with a 2-to-1 randomization, this indicated that the risk

¹ More information about dengue is available at <https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue> (accessed November 4, 2020).

of infection was seven-fold higher for vaccinated children than those in the control arm.

Researchers examined the potential origins of the infections observed in the trial. One hypothesis, Flasche explained, was that the increased susceptibility to severe disease was age related, because there was an age gradient to vaccine efficacy in which older cohorts displayed better protection. However, there could be a proxy for age—in this case, given the antibody-dependent enhancement of dengue, it could be that there was a higher proportion of dengue-naïve vaccinees in the intervention arm. Another hypothesis was that the vaccine was acting similarly to the natural infection. In unexposed individuals, it was possible that the vaccine was simulating an asymptomatic primary infection, thus increasing the likelihood of more severe secondary infection upon natural exposure. Yet the potential safety signal was only observed in children aged 2–5 years and was not observed during the trial in any participant aged 9 years or older. Flasche added that modeling suggested that even in dengue-naïve vaccine recipients, the lifetime net effect would be potentially positive despite the possibility of bringing forward risk (Ferguson et al., 2016).

Dengvaxia Uptake and Label Change

In spite of some uncertainty following the trials, Dengvaxia was licensed relatively quickly in about 20 countries for use in people aged 9–45 years, said Flasche. However, it was only widely used in parts of Brazil and the Philippines. He attributed this in part to a 2016 recommendation by the World Health Organization (WHO)² that restricted use of the vaccine to high-burden settings in which vaccinees averaged a 70 percent chance of having had dengue in the past. He suggested that only the Philippines and Brazil used the vaccine widely because it is difficult to calculate that risk percentage.

Sanofi, the manufacturer of Dengvaxia, announced a label change in November 2017. Additional studies enabled Sanofi to retroactively infer serostatus of vaccine recipients prior to vaccination. This provided a clearer picture of whether the potential risk was indeed age related or related to the serostatus of the vaccinees. Sanofi determined there was differential effect based on seropositive status; therefore, the label was changed to recommend the vaccine only for people who were seropositive due to previous dengue infection. However, more than 800,000 people in the Philippines and 300,000 people in Brazil had already been vaccinated with unknown serostatus, which Flasche asserted was a missed opportunity to better understand

² More information about WHO's first dengue vaccine position paper is available at https://www.who.int/immunization/newsroom/press/dengue_first_position_paper/en (accessed November 4, 2020).

which vaccine recipients were likely to see substantial benefit and which would potentially see increased risk brought about by vaccination.

Uptake of Dengvaxia in the Philippines

Flasche and colleagues studied cohorts in parts of the Philippines in order to estimate the likely effect of Dengvaxia in the 5 years following widespread vaccination (Flasche et al., 2019). An extrapolation from the trials' findings adapted to the Philippines cohort indicated dengue hospitalizations would decrease by an estimated 70 percent overall for the vaccinated cohort. Over the 5-year time period, they estimated that Dengvaxia vaccination would have averted (1) around 18 dengue hospitalizations among those who were seropositive at vaccination for each hospitalization among people who were dengue-naïve at vaccination and (2) about 10 cases of severe dengue among seropositive vaccine recipients for each case of severe dengue among those who were dengue-naïve at vaccination. Flasche said the balance of benefits and risks was therefore one-sided. Of the cases and hospitalized cases predicted to occur within 5 years of vaccination, an estimated 50 percent would be attributable to breakthrough infections among people who were seropositive and would therefore benefit from Dengvaxia vaccination. An additional 25 percent of cases would be those who were dengue-naïve at the time of vaccination, but who would have contracted the severe infection regardless. The remaining 25 percent would be vaccine-attributable with the risk brought forward.

The publicity around Sanofi's label change caused a social media frenzy, said Flasche. Parents were understandably scared of the possibility that their children may have received a potentially harmful vaccine. Even more confusing, it was impossible to determine whether a particular child's vaccine would prove to be harmful or of substantial benefit. This was a statistical problem, he noted, and humans do not typically think statistically when it comes to risk. Shortly after Sanofi's announcement, the Philippines suspended the entire Dengvaxia program and banned the vaccine in December 2017. Flasche added they even brought criminal charges against trial administrators and Department of Health officers. He pointed out that in Brazil, however, the response was markedly different. Although there was the potential for a similarly negative public response in Brazil, the announcement largely went unnoticed and controversy around Dengvaxia only took place in the Philippines.

Impact on the National Immunization Program

The fallout from the Dengvaxia vaccination campaign had a substantial negative impact on the national immunization program in the Philippines,

which Flasche characterized as a “massive blow.” In the wake of the Sanofi announcement, vaccine confidence plummeted in the Philippines (Larson et al., 2019). In 2015, about 82 percent of the population reported feeling that vaccines were generally safe; this dropped to 21 percent by 2018. Additionally, vaccination rates dropped in the national immunization program and particularly in the childhood program. For example, it took many years to achieve a relatively high level (88 percent) of measles vaccination coverage in the country by 2014, but this decreased to roughly 50 percent in 2019, with measles incidence rates now between 10–20 times higher than they were before the Dengvaxia controversy (Dyer, 2019; Lancet Editorial, 2019). This contributed to widespread transmission of measles, with measles partially overwhelming the national health care system. Furthermore, polio had largely been under control in the Philippines, but a recent polio outbreak in the country is a concern for global polio eradication, which is one of the most expensive global health efforts.³

Applying Lessons Learned to COVID-19

Flasche said there are lessons from the Dengvaxia controversy that can be applied to COVID-19 vaccination. “When we start vaccinating, the story is not over,” he cautioned. He advised nations to prepare for the likelihood of intense public scrutiny and the influence of personal agendas, which can be both helpful and harmful to vaccination efforts. Moreover, he noted that COVID-19 vaccination will involve age groups who do not typically receive routine vaccinations and that the temporal association with unexplained deaths may also pose a challenge.

Open access to vaccine-related data and the decision-making process can help to enable successful vaccination efforts, said Flasche. Conflicts of interest should be avoided, because they can contribute to the type of social media frenzy that occurred with Dengvaxia. To help assess safety in real time, it is important to understand background rates in order to respond to safety events with confidence. For instance, if a cohort of people aged 55 years is vaccinated, some will experience heart attacks that are temporally associated with the vaccine unless the background rate has been established. Without background rates and a strong public understanding thereof, it is difficult to confidently determine that a vaccine is safe. Systems should also be in place to monitor the effect of the vaccine in real time to facilitate risk/benefit analysis, particularly given the likelihood of a suboptimal number of doses being available for the initial rollout.

³ More information about the polio outbreak in the Philippines is available at <https://www.who.int/westernpacific/emergencies/polio-outbreak-in-the-philippines> (accessed November 4, 2020).

MEASURING BEHAVIORAL AND SOCIAL DRIVERS OF VACCINATION

Presented by Julie Leask, University of Sydney

Julie Leask, professor at the University of Sydney, Australia, described efforts by the Behavioral and Social Drivers (BeSD) working group at WHO to develop measures of the social and behavioral drivers of vaccination. The BeSD working group was formed to develop globally standardized tools to measure core components of the Increasing Vaccination Model, including people's thoughts and feelings, social processes, motivation, and practical issues regarding vaccination. She also explored the rationale for developing new tools to understand the vaccination gap of approximately 20 million children worldwide.

Vaccine Rates and Contributing Factors

The news media frequently focus on the role of the anti-vaccination movement in reducing vaccine acceptance, but Leask explained that barriers to high vaccination coverage extend beyond negative messaging about vaccination. A commonly held belief is that anti-vaccination messages lead to reduced acceptance, which leads to reduced coverage, which causes outbreaks. Leask noted that WHO listed hesitancy as one of the top 10 threats to global health in 2019;⁴ however, WHO also included fragile health systems and weak primary care in the list of top threats. These factors also influence vaccine uptake.

Examining global measles cases over the past 2–3 years demonstrates the complexity of factors that affect vaccine coverage, said Leask. Many of the countries with the highest numbers of cases have experienced mixtures of vaccine hesitancy and inadequate or disrupted health systems. Among such hot spots, Venezuela has had a major disruption to its health care system, Brazil has underserved regions, and the Ukraine has both vaccine hesitancy and inadequate health services. The United States has high measles vaccine coverage, but pockets of low coverage and multiple importations. Madagascar—which had the highest number of measles cases of any country during that period—has a weak health system, she noted. Political factors, such as the conflict and displacement of children in Yemen, have also contributed to measles outbreaks. Leask added that the Philippines had many years of inadequate immunization services prior to the compounding effects of the Dengvaxia vaccine safety event in recent years.

⁴ More information about WHO's top 10 threats to global health in 2019 is available at <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019> (accessed November 4, 2020).

Measuring the Vaccination Gap

The stagnation of vaccination coverage rates is a major global concern, said Leask. Global coverage of diphtheria, tetanus, and pertussis vaccine (DTP) dose 3 has remained at 85–86 percent for several years, leaving almost 20 million children either unvaccinated or undervaccinated.⁵ Determining the cause of this gap is an empirical question that warrants better measurement strategies. Leask noted several challenges with respect to current measures. One issue with current measures relates to the focus on measuring attitudes—such as what people think and how they feel about vaccination—without also considering important practical and logistical barriers to vaccination that also influence uptake. Further issues include the fact that many vaccination gap measures are not validated, with insufficient standardization to enable examination of change over time. Additionally, Leask noted that the binary notion of supply and demand oversimplifies the ways in which barriers to uptake are conceptualized, and that findings from the data already collected often go unused.

New Tools to Measure and Address Behavioral and Social Drivers of Vaccination

Leask emphasized that new measures are needed to understand the vaccination gap and its causes. To that end, WHO and the Vaccination Demand Hub,⁶ a network of partner organizations, have initiated an effort to develop globally standardized tools to measure the BeSD of vaccination. This involves examining various types of vaccine-related data: coverage, program performance, behavioral and social, and surveillance. Coverage data measure the rates and geographic distributions of those experiencing zero-dose, delayed, or undervaccination scenarios. Program data involves vaccine supply, wastage, policies, and legislation. Behavioral and social data can be used to identify barriers and drivers of vaccination per population group. Surveillance data measure disease burden. The objective of this effort to develop new tools to measure and address BeSD is to boost the availability, quality, and usability of local and global data on acceptance and uptake by (1) supporting assessments of undervaccination to inform policy making and planning; (2) informing the design and evaluation of targeted interventions; (3) tracking comparable trends over time, such as any decline in vaccine confidence; and (4) contributing to regional and global reporting processes

⁵ More information about progress and challenges with achieving universal immunization coverage is available at https://www.who.int/immunization/monitoring_surveillance/who-immuniz.pdf?ua=1 (accessed November 4, 2020).

⁶ More information about Vaccination Demand Hub is available at <https://www.demandhub.org> (accessed November 4, 2020).

such as the Immunization Agenda 2030 (IA2030), the WHO/United Nations Children's Fund (UNICEF) Joint Reporting Form, and Gavi 5.0.

Leask outlined the three new types of tools developed under this effort. The Childhood Immunisation Survey is designed for parents and caregivers to provide their perspective on what might be contributing to their children's vaccination status.⁷ In-depth BeSD interview guides were developed to dig deeper into the perspectives of caregivers as well as vaccine providers, community stakeholders, and authorities across health and immunization systems. Implementation guidance has also been developed to inform local adaptation, testing, and use of tools. Informed by design-thinking principles, the guidance considers the personae of vaccine program managers and field researchers and what they need to know to use these tools and make changes based on their findings. Leask noted that a challenge in developing global tools is the need to consider the multiple contexts in which a single set of measures will be used, and thus the need to develop flexible tools that will suit variable contexts of delivery, provision, income level, and access.

Increasing Vaccination Model

The BeSD working group developed the Increasing Vaccination Model, which is adapted from work led by Noel Brewer (Brewer et al., 2017a). This model stipulates that motivation to vaccinate is influenced by beliefs and feelings about vaccination as well as by social processes. Leask explained that people's thoughts and feelings about vaccination include confidence in vaccine benefits, vaccine safety, and in the provider, as well as religious beliefs. Social processes include the social influences of the provider, family, and community, in addition to gender equity and the decision-making autonomy that a woman in the family has. These come together to influence motivation, which is the point at which hesitancy is located within this model. Leask noted that hesitancy is conceptualized as a motivation in this framework, rather than as a behavior. Practical issues are those that affect whether a person is vaccinated, including awareness, availability, ease of access, affordability, service quality, and provider-patient relationships. When a person is sufficiently motivated and practical issues are not sufficient barriers to prevent vaccination, the child receives recommended vaccines.

To illustrate how the Increasing Vaccination Model can be used to help create measurement tools, Leask described some of the survey items. To better understand the role of gender equity in caregiver motivation to vaccinate,

⁷ The long form of the Childhood Immunisation Survey has 22 items; the short form has 5 items.

the survey asks: “In your family, who has the final say about vaccinating your child?” Answer options include “mother,” “father,” “both parents,” “grandparents,” “other caregiver,” “not sure,” and “declined.” The in-depth interview guide asks: “Tell me about how you decided to vaccinate (or not vaccinate) your child(ren); who else was involved in the decision?” Leask noted that open-ended questions such as this are analyzed differently than the multiple-choice survey questions. To examine ease of access issues, the survey includes this question: “How easy is it to get vaccination services for your child?” The in-depth interview states, “Walk me through what you do on the day of vaccination; start at the very beginning.”

Field Testing the Increasing Vaccination Model

Leask said that these new tools are being field tested in countries like Sierra Leone, where the BeSD working group partnered with Statistics Sierra Leone to integrate the tools into preparation for a national survey.⁸ This involved cognitive interviews in which researchers studied how people interpret the survey questions to ensure that the questions are phrased in a way they can be understood as intended. This process includes asking participants a question, then asking them questions about the question. For example, participants are asked, “How important do you think vaccines are for your child’s health?” They can select from “not at all important,” “a little important,” “moderately important,” or “very important.” Next, they are asked these questions: “What were you thinking about in deciding your answer?” “What do the words ‘important for your child’s health’ mean to you?” “Did the response options fit with the sort of answer you wanted to give?” This type of cognitive interviewing has been performed in both rural and poor urban communities in Sierra Leone.

Leask outlined three phases of in-country field testing (efforts were in the second phase as of August 2020). The first phase includes consultation with WHO’s Expanded Programme on Immunization managers and partners, analysis of existing tools and literature, and expert review and consultation. The second phase includes development of training and testing materials, testing, and local adaptation. The third phase involves implementation of scaled pilots for psychometric validation and integration. Leask noted that COVID-19 has stalled in-country field testing, so testing will be undertaken by a company with data collectors in-country. The goal is to complete data collection by April 2021 and develop a data repository for reports from countries so that metrics and indicators can be tracked for IA2030 and

⁸ More information about Statistics Sierra Leone is available at <https://www.statistics.sl> (accessed November 4, 2020).

Gavi 5.0.^{9,10} WHO's capacity-building efforts will include gathering data for analysis and translation, as well as for building social and behavioral research capacity in the field of vaccination. WHO is also planning feedback loops for continuous learning from the implementation of the new tools to inform revision work in the future, she added.

UNDERSTANDING DRIVERS OF VACCINE HESITANCY

Presented by Julie Bettinger, The University of British Columbia

Bettinger explored drivers of vaccine acceptance, hesitancy, and refusal. She described the characteristics common to different groups along the spectrum of vaccine hesitancy to explore why interventions that are effective in moving certain people toward vaccine acceptance may not work for others.

Immunization Rates and Trends in Canada and the United States

According to a UNICEF analysis on immunization, Canada ranked 28th out of 29 developed countries for immunization coverage of measles, polio, and DTP dose 3 in children aged 12–23 months.¹¹ Bettinger noted that Canada's coverage rate of 84 percent is similar to some low- and middle-income nations in the world. The United States ranked 23rd out of 29, but remained in the bottom third of rich countries with a coverage rate of 93 percent. The analysis also compared rates of immunization coverage by antigen for pneumococcal infection; varicella; measles, mumps, and rubella (MMR); *Haemophilus influenzae* type B; polio; DTP; rotavirus; and hepatitis B.¹² Canada hit the target 90 percent coverage rate recommended by WHO for two of eight antigens (MMR and polio), whereas the United States had four antigens covered at the target rate—varicella, MMR, polio, and hepatitis B (PHAC, 2016).¹³ She pointed out that in comparing jurisdictions and coverage rates, data are often collected differently, resulting in “apples and oranges” scenarios in which true, parallel comparisons cannot be derived.

⁹ More information about IA2030 is available at https://www.who.int/immunization/IA2030_draft_4_WHA.pdf?ua=1 (accessed November 4, 2020).

¹⁰ More information about Gavi 5.0 is available at <https://www.gavi.org/our-alliance/strategy/phase-5-2021-2025> (accessed November 4, 2020).

¹¹ More information about the Innocenti Report Card is available at http://www.unicef-irc.org/publications/pdf/rc11_eng.pdf (accessed November 5, 2020).

¹² More data from the National Center for Health Statistics are available at <https://www.cdc.gov/nchs/hsr/contents2017.htm> (tables 012, 066, and 067) (accessed December 4, 2020).

¹³ Results from the 2017 Childhood National Immunization Coverage Survey conducted by Health Canada can be found at <https://www.canada.ca/en/public-health/services/publications/healthy-living/2017-vaccine-uptake-canadian-children-survey.html> (accessed February 25, 2021).

For example, these data from Canada were taken for children at 2 years of age, whereas the U.S. data include children from 19–34 months of age. Bettinger suggested that the Canadian data might be more similar to U.S. data if the same age range were used. This illustrates how lack of uniform data measurements can make it challenging to identify areas of low vaccine coverage on a global scale.

Bettinger reported that the United States and Canada had similar rates of influenza vaccination from 2018–2019 (PHAC, 2019).^{14,15} In Canada, 42 percent of adults were vaccinated, compared to 45 percent in the United States. In both countries, more females were vaccinated than males and around 70 percent of older adults were vaccinated. She added that rates varied not only by age group but also by jurisdiction. For example, 34 percent of adults were vaccinated in Nevada versus 56 percent of adults in Rhode Island. This demonstrates that national estimates can be helpful in global comparisons, but examining data by age, jurisdiction, and gender is also valuable.

Estimates of non-vaccination rates also vary by location, said Bettinger. In Canada, the percentage of children who never received any vaccines across all age groups is estimated to be 1.5 percent nationwide, but provincial estimates range from 3–5 percent (Wilson et al., 2015). Rates vary further by age group, the community within a province, and by vaccine. For instance, in the province of Alberta, non-vaccination rates for DTP are 5.5 percent, compared to 15 percent for varicella. Even if a province's coverage rate is much higher than the national average, community rates may be much lower, she added. Some communities in British Columbia have antigen-specific coverage rates lower than 50 percent, particularly for the human papillomavirus (HPV) vaccine. In the United States, the 2017 estimate for non-vaccinated children aged 3 years and under was 1.1 percent—which increased from 0.7 percent in 2013—but the estimated rate for uninsured children was much higher, at 7 percent (Mellerson et al., 2018). Bettinger pointed out one vaccine trend that is fairly consistent across Canada: a recent increase in exemptions. Ontario (which is one of only two provinces to mandate vaccination upon school entry) has had an increase in nonmedical exemptions from 0.4 percent in 1985 to 2.5 percent in 2005; this trend has continued to increase since then, she added. In the United States, the 2017 exemption rate for kin-

¹⁴ Results from the 2018–2019 Seasonal Influenza Vaccination Coverage Survey conducted by Health Canada are available at <https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html> (accessed February 25, 2021).

¹⁵ More information about the 2018–2019 influenza season vaccination coverage in the United States is available at <https://www.cdc.gov/flu/fluview/1819season.htm> (accessed November 5, 2020).

dergarterners was 2.2 percent, which varied by jurisdiction (e.g., 0.1 percent in Mississippi versus 7.1 percent in Alaska).

Continuum of Vaccine Acceptance Model

Bettinger emphasized that vaccine coverage, non-coverage, and exemption rates are important, but “they do not tell the whole story.” These data allow experts to focus attention on particular vaccines, age groups, jurisdictions, and other demographics (e.g., the uninsured) to understand reasons for low vaccine coverage, but the data do not directly identify vaccine-hesitant individuals. She cautioned against conflating low vaccine coverage with vaccine hesitancy; the latter is just one of multiple factors that affect coverage rates. As evidenced in “anti-vaxxer” stereotypes, the media tends to propagate a certain image of vaccine-hesitant people as relatively privileged and philosophically opposed to vaccinating their children. However, vaccine hesitancy is actually a motivational state that a person might experience at different stages in life; it can also vary over time, place, and jurisdiction. For example, a woman who strongly believes in vaccines and is fully vaccinated might be hesitant toward an influenza immunization while she is pregnant.

Bettinger explained how the Continuum of Vaccine Acceptance Model developed by WHO’s SAGE Working Group on Vaccine Hesitancy and other academic researchers accounts for shifts in an individual’s vaccine hesitancy over time (Benin et al., 2006; Dubé et al., 2016; Leask et al., 2012; MacDonald et al., 2015; WHO, 2014).¹⁶ Generally, people fall into one of five categories along the spectrum of vaccine hesitancy:

1. those with no doubts or concerns,
2. those with minor doubts and concerns,
3. those with many doubts and concerns,
4. those who are late or selective vaccinators, and
5. those who refuse all vaccinations.

People with no doubts or concerns are individuals who have already made a decision about vaccination, so they do not qualify as hesitant. Likewise, people *refusing* all vaccinations have also already made a decision and are therefore not considered hesitant. It is the middle groups on the spectrum that are most aptly described as “vaccine hesitant” or in a “state of hesitancy.” Furthermore, even though individuals with minor or many doubts and concerns are considered hesitant, they typically still choose to receive all vaccinations. When looking at coverage rates, even those in the

¹⁶ Bettinger emphasized that while her focus in this presentation is on vaccine hesitancy, it is only one aspect of vaccine acceptance, and other factors play a role.

“many doubts and concerns” group tend to be among the 84 percent of Canadians and 93 percent of Americans who are vaccinated. However, there are individuals within that group who may move up or down the spectrum of vaccine acceptance.

The first group (those with “no doubts or concerns”) is composed of people who have accepted vaccines. Bettinger explained that these individuals typically consider vaccines safe and important. Often, they have a lot of trust in their health care provider and receive a strong recommendation from this provider. They are often heavily influenced by the social norm of vaccination—that is, their friends and families are vaccinated, and a positive vaccination message is reinforced in their community and among their contacts. The groups with “minor doubts and concerns” and “many doubts and concerns” have vaccine hesitancy. They tend to be more focused on vaccine risk and often have low perceived benefits of vaccination and low perceived risk for vaccine-preventable disease. They may not think they need to vaccinate and do not see the risk of not vaccinating, she added, noting that these groups can easily move up or down the continuum due to a variety of influences. For example, a health care provider they trust who provides a strong recommendation can influence them toward vaccinating, whereas a vaccine safety scare can shift them toward a decision not to vaccinate.

The fourth group, those who “vaccinate selectively and late,” are individuals who have significant doubts about the safety and necessity of vaccines, said Bettinger. They tend to actively seek information and may have conflicting feelings about whom to trust. People in this group may initially meet with doctors without bringing their children. Additionally, they may make multiple appointments at different clinics in order to weigh information from various sources before making vaccination decisions. This group also tends to be heavily influenced by social networks. However, unlike those with no doubts or concerns about vaccination, their social network may not be vaccinating. Friends or relatives can be a contributing factor to hesitancy when they tell an individual that vaccines are unsafe. Many of these individuals have had negative experiences with health care providers, the medical system, or vaccines. She noted that in some cases, these negative experiences have nothing to do with vaccines but were powerful enough to make people distrustful of any advice from health care providers.

The fifth group, those who “refuse all vaccinations,” are sometimes termed *anti-vaxxers*. Bettinger said that this group should not be considered as vaccine hesitant because they have made their decision not to vaccinate, often with strong conviction. Sometimes this is attributable to a “natural” attitude toward health, but she noted that strong religious or moral considerations drive such decisions just as often. Distrust in the medical community is also common in this group. She added that while it can be very challenging to move this group toward vaccine acceptance, it is not impossible.

However, the intervention that may work with someone with minor doubts and concerns will not necessarily work for someone who has decided not to vaccinate and has strong motivation behind that decision. For example, a presumptive communication approach in which a doctor says “Today you are going to be vaccinated” may be effective for someone who does not have any doubts or concerns around vaccination, but for someone who is a late or selective vaccinator, that approach could reduce trust and make the person even less likely to vaccinate. Bettinger added that people in this group often seek out a provider who will listen to them and discuss their concerns, so health providers should consider where patients are along the hesitancy spectrum in deciding what type of intervention to use.

THE INCREASING VACCINATION MODEL

Presented by Noel Brewer, University of North Carolina at Chapel Hill

Brewer provided more detail about the Increasing Vaccination Model and its propositions about how to influence vaccine behavior. He described the relative effect of different types of interventions based on those propositions and suggested ways forward to apply the model toward influencing vaccination behavior. In collaboration with Julie Leask, Gretchen Chapman, Alex Rothman, and Allie Kempe, Brewer developed the Increasing Vaccination Model to help address low vaccination uptake (Brewer et al., 2017a). He noted that uptake is not the only factor affecting coverage rates—delayed vaccination and instability in vaccination also play a role. The premise of the model is that certain factors influence individuals to schedule, consent to, delay, or refuse vaccinations. The model groups the factors that motivate vaccination into three categories: what people think and feel, social processes, and direct behavior change.

Proposition 1: Thoughts and Feelings Influence Vaccination Behavior

The first proposition of the model is that people’s thoughts and feelings influence their vaccination behavior, said Brewer. Thoughts and feelings can encompass disease risk appraisal, vaccine confidence, and motivation. For example, an individual may express risk appraisal by thinking, “I am concerned about getting pneumonia.” That person’s vaccine confidence might be that the pneumonia vaccine is effective and safe. The risk appraisal and vaccine confidence would inform the individual’s motivation—in this case, the intention to receive the pneumonia vaccine—that leads the person to vaccinate. In cases where disease risk appraisal and vaccine confidence lead to vaccination hesitancy rather than motivation, the result may be vaccination refusal or delay.

Although non-experimental and correlational studies provide support for this proposition, available evidence from randomized trials does not. Presently there is little evidence to suggest interventions that target people's thoughts and feelings affect vaccination behavior (Brewer et al., 2017a). For example, the following interventions were found to have minimal or no likely effect on participants: messages that increase disease risk appraisals, education campaigns that increase vaccination confidence, decision aids, and motivational interviewing. Brewer did note that there is some evidence to suggest messaging for the purpose of increasing disease risk appraisal may have some effect, but a recent meta-analysis did not find this to be an effective method for increasing vaccine uptake (Parsons et al., 2018). He added that, owing to a lack of reliable study data, the effectiveness of educational campaigns to increase vaccine confidence is unclear. Interventions to increase confidence may eventually be shown to indicate increased vaccine uptake, but so far no randomized controlled trials have been conducted. As a result, evidence that confidence is a vaccination driver is lacking. Brewer maintained that decision aids are not effective in increasing uptake. Motivational interviewing has some promise, but there is still no randomized controlled trial evidence available to support it.

Proposition 2: Social Processes Influence Vaccination Behavior

The second proposition of the Increasing Vaccination Model is that social processes influence vaccination. Brewer explained that social processes begin with an individual's virtual or in-person social network (e.g., family, friends, colleagues, neighbors). Homophily, or the tendency to seek out people similar to oneself, often shapes individuals' social networks. Ideas propagate through one's social network and generate social norms in people's minds that can guide vaccination behavior. Social processes also include social preferences. For example, a social preference for altruism can motivate a person to vaccinate in order to help other people avoid becoming ill. Alternatively, a person's social preference for "free-riding"—in this case, assuming that everyone else is going to get vaccinated—can be associated with vaccine refusal.

Support for the proposition that social processes are central to vaccination behavior comes from both correlational and experimental studies, but there is little evidence from randomized controlled trials (Brewer et al., 2017a). Although the available evidence suggests that there is minimal or no likely effect of messaging designed to change altruism or free-riding beliefs, other types of interventions focused on social process interventions seem to have a modest effect on vaccination behavior. Descriptive norm messages are promising and have been effective in other areas, but strong evidence is not yet available for their use in vaccination efforts. Similarly, Brewer noted

that social network interventions that build on contagion have worked well in other areas and are promising in the area of vaccination, but trials have not yet been published.

Proposition 3: Direct Behavior Change Influences Vaccination Behavior

The third proposition is that vaccination uptake can be affected by changing behavior directly, rather than changing how people think and feel. Brewer explained that this involves building on favorable intentions without attempting to change underlying thoughts and feelings. To build on favorable intentions, the use of reminders, prompts, and primers can help keep vaccination on people's minds. Another useful strategy is to reduce barriers with logistics or behavioral defaults. For people who do not have favorable intentions toward vaccination, behavior can be shaped by offering incentives, implementing sanctions, and perhaps even requiring vaccinations by mandate.

Clear evidence from intervention studies supports the proposition of changing behavior directly, said Brewer (Brewer et al., 2017a). All types of behavior-change interventions indicate a modest or substantial likely effect on vaccination behavior. For instance, presumptive health care provider recommendations, onsite vaccination, default appointments, incentives, and vaccination requirements all show a substantial likely impact. Reminders and callbacks showed a modest effect, which Brewer surmised would be greater if provided consistently with appropriate follow-through in primary care. The available data also suggest that these reminders are particularly effective when they are centralized and identified as “clinical centralized reminders [callbacks]” (Kempe et al., 2015). Brewer added that the other direct behavior-change efforts showing modest likely effect on vaccine uptake were implementation intention interventions and mere measurement interventions. Onsite vaccination, default appointments, incentives, sanctions, and vaccination requirements were all found to have a substantial effect.

Presumptive Recommendations

To test the hypothesis that presumptive recommendations—which use language that assumes parents are ready to vaccinate when introducing the vaccine—would increase uptake, Brewer and colleagues trained providers in 30 clinics in North Carolina and found that presumptive recommendations were associated with increased vaccination and reduced time to vaccinate (Brewer et al., 2017b; Opel et al., 2013). In the intervention arm, the physicians started appointments by announcing that the child was due for an HPV vaccine and then pivoted to a more consultative interaction if the reaction

warranted. This resulted in a 5 percent increase in vaccine uptake. By contrast, when physicians began appointments with a consultative interaction, there was no statistically significant increase in vaccine uptake.

Another direct behavior-change intervention study on default vaccination appointments found that people who are automatically scheduled for an appointment for a seasonal flu vaccine (without first requesting it) are more likely to come in for the vaccination (Chapman et al., 2016). This opt-out method resulted in 27 percent of patients being vaccinated. When an opt-in method was used, the vaccination rate dropped to 18 percent, which was only slightly higher than the control group who received no letter regarding vaccination (17 percent). Brewer emphasized that this study used a registry and medical records to account for vaccinations provided at both doctors' offices and at flu clinics, so these figures do not represent a displacement of vaccinations from one location to another, but rather an actual increase in overall uptake.

In a study on incentives used in India, researchers randomly assigned villages to a control group, a monthly vaccination camp, or a monthly vaccination camp with incentives (Banerjee et al., 2010). The incentives provided were a kilogram of lentils per shot, worth approximately 75 percent of 1 day's wage, as well as a set of metal thali plates (food serving platters) at completion. The study found that onsite vaccination increased uptake. At the end of the intervention, 6 percent of 18-month-olds in the control group were fully vaccinated, compared with 18 percent in the monthly vaccination camp; the rate increased to 39 percent in the villages that provided monthly vaccination camps with incentives.

Ways to Apply the Model to Influence Vaccination Behavior

Based on his review of this data, Brewer said that the proposition that people's thoughts and feelings affect vaccination behavior is not as promising in trying to improve vaccine uptake. Social processes are a promising area, but they are currently understudied and poorly understood with respect to vaccination, underscoring the need for additional funding and research in this area. Direct behavior change has been shown to increase uptake, but those approaches remain underutilized. Brewer noted that most of the data he presented come from high-income countries (e.g., Australia, the United States, countries in Western Europe), highlighting the need for more data from low- and middle-income settings, which have strengths that could be brought to countries of all income levels.

Brewer highlighted that policies and programs utilizing direct behavior change are effective. He hypothesized that, despite the current lack of data, the underlying reasons why such direct behavior-change initiatives work are confidence in vaccination and the vaccination system, as well as trust that

vaccinations are wholesome and will benefit both children's health and the health of the general population. He posited that this level of confidence may be a prerequisite for effectively increasing vaccine uptake. If this is the case, it would indicate that confidence—something that people think and feel—may have a role in the efficacy of direct behavior change. Thus, building confidence could help if used as a tool to encourage the public and policy makers to engage in the programs, projects, and policies that are effective in increasing vaccination. He noted that strong policies are needed to overcome some of the recent instability in vaccine coverage. For instance, HPV vaccine coverage is low in the United States and is an area that warrants urgent intervention. Seasonal influenza vaccination is another area that warrants immediate focus during the COVID-19 pandemic, because (1) seasonal influenza vaccination in 2020–2021 can be used as a model for delivering the COVID-19 vaccine, and (2) controlling seasonal influenza rates may help avoid dual global pandemics. He suggested that when a vaccine for COVID-19 becomes available, tools to increase vaccine uptake should be used within programs built on strong logistics and based on concretely effective strategies, rather than focusing exclusively on media campaigns.

DISCUSSION

Prioritizing Vaccination Behavior Driver Types

Vaccine promotion often focuses on educating, convincing, and persuading people to vaccinate their children and themselves, said Buttenheim. She noted that Brewer's presentation deemphasized those types of interventions because of a lack of evidence of effectiveness, and instead he prioritized behavioral interventions. Furthermore, he hypothesized that confidence may be a required precedent for behavior change. Buttenheim asked panelists to discuss the tension or dichotomy often indicated between a focus on education or persuasion and a focus on behavior changes. Brewer said that the strongest motivator of vaccination is a provider recommendation, be it from a physician, a nurse, or anyone on the primary care team. He noted that a provider recommendation is a powerful tool for increasing uptake, but the reason for its effectiveness is not yet understood, although the availability of the vaccine and the social contract could be at play. Thus, while provider persuasion can work, it is not yet known which process that persuasion is operating through, he said.

Leask speculated that regardless of the level of vaccine confidence and motivation, the greatest barriers to vaccination may be at the population level around practical issues. This could account for why system-level changes are effective. She suggested that interventions around thinking and feeling that help to communicate to the public about vaccination programs

are important components of the logic model of causal change through which vaccination programs can become successful. She added that the confidence of a politician, leader, or program manager is among the different layers needed for vaccination programs to be successful. Although the ways people think and feel about vaccines are an important part of the mechanism, and communicating about vaccination is important, she contended that such interventions alone are not sufficient to substantially improve vaccine coverage.

Bettinger agreed that a focus on structural interventions such as mandates and incentives (which are more common in the United States and Australia than in Canada) can be effective by sending a clear message that vaccinations are considered important at a structural level. Furthermore, this has the effect of encouraging individuals who may not vaccinate simply because of inconvenience. In addition to these behavior-change interventions, she emphasized that the social process of altruism can impact vaccination behavior. It is difficult to quantify concepts like altruism, but Bettinger has performed qualitative research with vaccine-hesitant parents who were moved toward vaccinating. Such parents often question why vaccination matters and make statements such as: “It’s my decision,” “Why do you care?” and “It’s my child.” However, in Bettinger’s experience, some vaccine-hesitant parents were motivated to vaccinate by learning more about herd immunity and how their vaccination decision actually has an effect on their community. She added that in British Columbia, there are some religious communities that will not vaccinate but are willing to participate in other types of control and containment measures. This demonstrates the importance of understanding the context in tailoring work with a community or individual.

Flasche emphasized that in the unprecedented challenge of the COVID-19 pandemic, experts should be aware that the factors involved in vaccine hesitancy, delay, and refusal may shuffle as the global pandemic impacts more and more aspects of society. He predicted that there may be a range of responses from extreme vaccine demand in communities wanting to end social distancing as quickly as possible to skepticism about the need for a vaccine from parts of the world that have not been as heavily impacted by COVID-19. Therefore, the relative contribution of factors driving vaccination behavior may be different in this context compared to past situations. Furthermore, Flasche added that the conditions of the pandemic will be different between and within various parts of the world.

Brewer said that organizations will be remiss if they choose not to be a part of the conversation on social media. Current communication around COVID-19 vaccination needs improvement, especially the messaging coming from agencies and policy makers. So little is currently known about the virus that the public naturally wants to fill in the gaps in that knowledge.

He cautioned against framing vaccines as “new” because of the unprecedented speed of development. Instead, he suggested identifying a single spokesperson, or multiple spokespeople representing diverse communities, to communicate regularly with the public about what is known about the vaccines. That way, Brewer explained, when COVID-19 vaccines eventually arrive, the public will be familiar with them as a guaranteed eventuality. Just as people have grown accustomed to the reality of COVID-19, they can grow accustomed to the idea of a vaccine.

Recommendations for COVID-19 Vaccine Acceptance

Bутtenheim asked about first-priority strategies to increase acceptance of the upcoming COVID-19 vaccine. Flasche reiterated that a provider recommendation is potentially the biggest factor influencing a person’s likelihood of getting vaccinated; therefore, strong recommendations from providers could have the largest possible impact. He added that including clear and digestible information on potential benefits and risks, as well as a quick overview of what is known and yet to be known about the vaccine, could be included with the recommendation. Leask said that based on vaccination conversation research, presumptive communication could be influential (Randall et al., 2020). If a patient is eligible for a vaccine that is available with demonstrated safety and effectiveness, Leask suggested that the provider could say: “You are eligible for the COVID-19 vaccine. I think it would be good if you had it. Do you have some questions?” Ideally, the patient would have received some information before the visit, even in the doctor’s waiting room. Leask noted that this approach to the vaccination conversation includes presumptive communication as well as space for the patient to ask questions, simultaneously honoring the need for valid consent. She continued that because the vaccine is new, people will likely have questions, but the conversation can still be framed around a recommendation. If a patient is particularly hesitant, a slightly different pathway could be used. She added that in her leadership role with the Sharing Knowledge About Immunisation project, she developed a primary care provider communication package for childhood vaccination that includes pathways aligned with differing positions on vaccination and immunization knowledge-sharing tools.¹⁷ Brewer said that he and his colleagues have developed the “announcement approach,” in which the medical care provider announces that the child is due for vaccination.¹⁸ He said

¹⁷ More information about the Sharing Knowledge About Immunisation project can be found at <https://www.ncirs.org.au/our-work/sharing-knowledge-about-immunisation> (accessed February 25, 2021).

¹⁸ More information about the announcement approach is available at www.hpvig.org (accessed November 5, 2020).

the key is to refer to vaccines in a similar manner to all of the other services offered in the clinic or medical office. If parents have questions, the process slows down to meet their needs. He suggested first identifying the parent's main concern so it can be addressed.

Targeting Specific Populations

On the topic of tailoring vaccination programs to target specific populations, Bittenheim asked about data on coverage rates for specific racial and ethnic groups or homeless populations. Brewer replied that in the United States, the federally funded Vaccines for Children Program pays for approximately half of all vaccines for children aged 18 years and older.¹⁹ Although Vaccines for Children charges an administration fee of up to approximately \$17, all vaccines are free and families are not charged this fee if they cannot afford it. He said there are some options for families that are homeless or without a permanent place to live, the most widely available being a visit to the local health department. Understanding the logistical barriers to homeless families' ability to get free and low-cost vaccines is important, Brewer said. He acknowledged that vaccine access for homeless adults is more complicated and stated that he is less familiar with that population.

Brewer noted the complexities involved in understanding why different ethnic groups have higher or lower vaccine coverage. For instance, African American adults are less likely to get the influenza vaccine than white adults, yet African American families are more likely to get the first dose of HPV vaccine for their children than their white counterparts. Brewer said the mechanisms behind this are not clear. Emphasizing that rates of the HPV and flu vaccine in the United States are low, Brewer highlighted the need for coverage rates to increase across all groups of Americans. He suggested that lower interest among African American people in getting the COVID-19 vaccine may be a durable problem, as is uptake of the seasonal influenza vaccine. If programs can work now to address problems with uptake of the seasonal influenza vaccine, it could be used as a model for encouraging uptake of COVID-19 vaccines when they become available.

Bettinger highlighted the need to better understand racial inequities in the United States. Some of the disparity is likely related to social determinants of health, but other factors are likely involved that are not yet understood. She noted that Canada has similar health disparities within its aboriginal population that cannot be completely explained by health inequities. In Canada, a history of racism and oppression toward the aboriginal population carries into the present day. It influences how various aboriginal

¹⁹ More information about the Vaccines for Children Program is available at <https://www.cdc.gov/vaccines/programs/vfc/index.html> (accessed November 5, 2020).

communities view Western medicine and health care providers, as well as the level of trust they have in allowing health care interventions to come into their communities. She added that local community contexts should be explored to understand whether trust issues, access issues, or other types of issues are contributing to low vaccination rates.

Leask said that there was once a vaccination gap between Indigenous and non-Indigenous populations in Australia, but targeted efforts have successfully eliminated this gap in certain age groups, with coverage rates for 5-year-old children in Indigenous communities now higher than the rate for non-Indigenous 5-year-old children.²⁰ She noted that good recordkeeping is partly responsible—Australia has a national registry that enables vaccination data for every child to be tracked. Culturally appropriate, respectful services administered through reminder systems also increased vaccination rates. For example, in a region of New South Wales, two Aboriginal health workers were employed to contact every single parent of a newborn identified as Aboriginal or Torres Strait Islander, obtain their mobile phone numbers, and send them a short message service (SMS) just before their babies' vaccinations were due (Cashman et al., 2016). Leask said this initiative closed the immunization gap for 12-month-olds in this district and inspired the state government to employ an Aboriginal immunization coordinator in each local health district. Ensuring that Aboriginal people are employed to support immunization programs and influence their communities is key, she added. Australia closed the gap in Aboriginal children's immunization rates in New South Wales partly through that program and partly from broad, upstream legislative changes that have resulted in more children getting vaccinated on time all over Australia. Leask concluded that the success stories in Australia can be attributed to ensuring cultural respect, understanding barriers, and comprehensively addressing those barriers.

Brewer also suggested that in designing systems to deliver vaccines, context should be at the forefront to avoid overemphasis on hesitancy. Furthermore, instead of assuming that people are disinterested or unwilling to vaccinate, focus ought to be shifted toward understanding how certain groups of people are systematically excluded from access. For instance, the reasons why rural areas of the United States tend to have lower vaccination rates are unclear, which warrants investigation into how people access vaccinations in rural health systems. With respect to people experiencing homelessness, Leask suggested working to increase vaccine uptake by leveraging

²⁰ More information on vaccine coverage in Australian Aboriginal and Torres Strait Islander peoples is available at <https://www.health.gov.au/health-topics/immunisation/childhood-immunisation-coverage/immunisation-coverage-rates-for-aboriginal-and-torres-strait-islander-children> (accessed May 20, 2021) and <https://www.health.gov.au/health-topics/immunisation/childhood-immunisation-coverage/immunisation-coverage-rates-for-all-children> (accessed December 18, 2020).

existing outreach services on the ground to bring vaccines to the places those populations are staying.

Addressing Vaccination Misinformation

Buttenheim asked about strategies that laypeople can use to combat misinformation when talking to others who are vaccine hesitant. Referencing an article she wrote on this topic called “Four Ways to Talk to Vaccine Skeptics,”²¹ Leask outlined several options, beginning with choosing one’s battles (Leask and Steffens, 2019). “If somebody is dead-set against vaccines, you may be wasting your time,” she said. When dealing with a family member or close friend, for example, she suggested having a respectful conversation in which both parties can share their concerns and position. Sometimes it will be necessary to agree to disagree, but if someone has had a particularly negative vaccination experience, they should be listened to and potentially referred to specialist immunization clinicians who can listen to their story and help them sort through what happened. However, Leask noted this approach can feel like “procedural justice” for the person who had the negative experience. For people who are only slightly hesitant about vaccines, it may be worth investing some time with them. Evidence suggests that providing information to correct misguided thinking can be more effective than doing nothing at all. However, she pointed out that this can backfire if confirmation bias affects the way a person with strong beliefs around vaccination receives a message.

Brewer suggested “taking the long view.” First, he said that it is the job of doctors to talk to people about vaccination; it is not the layperson’s job to convince people they know to vaccinate, and they should not be expected to have expert knowledge. For those who want to have the conversation, he recommended following the advice in Leask’s article. He added that many comments on social media are not actually made by people; they are generated by bots that can be ignored and blocked. He added that when addressing vaccine hesitancy or misinformation, it is helpful to identify one’s role (e.g., health care provider, friend, or someone speaking to the public who is trying to protect oneself in the process). For public figures who are addressing vaccine misinformation, Brewer recommended guidance issued by WHO titled “How to Respond to Vocal Vaccine Deniers in Public,”²² which provides two effective options: (1) debunking myths by identifying misinformation

²¹ Read the article on *The Conversation* at <https://theconversation.com/4-ways-to-talk-with-vaccine-skeptics-125142> (accessed February 25, 2021).

²² WHO’s guidance on how to respond to vocal vaccine deniers in public is available at https://www.who.int/immunization/sage/meetings/2016/october/8_Best-practice-guidance-respond-vocal-vaccine-deniers-public.pdf (accessed November 10, 2020).

point by point and (2) identifying the person's conversational ploys, such as "moving the goal post" or denying evidence. Bутtenheim added that these two approaches are called "inoculation theory," a communications strategy in which a small dose of misinformation, identified as such, is sandwiched between the correct information. She discussed another resource for people engaging on social media around vaccinations: a group called Shots Heard Round the World.²³ Formed by two American pediatricians, this group has been effective at countering social media attacks on health care providers and other immunization supporters. She added that lending support on social media is a useful way to counteract some of the misinformation activity on those platforms.

Influenza and COVID-19 Vaccination

Bутtenheim asked whether 2020 seasonal influenza vaccination programs should be tailored to anticipate the release of the COVID-19 vaccine. She queried further if the anticipated public interest in a COVID-19 vaccine might be used to promote and boost seasonal influenza vaccine coverage. Bettinger replied that she is using the fall seasonal influenza vaccine program as a trial run for COVID-19 vaccines. Similar populations will be targeted for these vaccines, and there are many pandemic-related logistical issues to address for both. Measures such as social distancing need to be in place for influenza vaccine delivery, she noted, and communication strategies developed for the influenza vaccine can be applied to the forthcoming COVID-19 vaccine. If enough educational information is available, then one-on-one communication can take place between providers and patients. Bутtenheim asked Bettinger which factors have had the greatest effect on coverage rates—hesitancy and motivation challenges or logistics, hassle, procrastination, and challenges related to behavior change. Bettinger responded that both are substantial challenges, but the extent to which each contributes separately to vaccine coverage issues is unclear. An additional challenge in Canada is that the seasonal influenza vaccine is not universally covered in all provinces and territories, which further complicates efforts to measure the drivers of low coverage.

Brewer pointed out that if families do not feel safe getting a flu vaccine, it will pose a barrier to the delivery of a COVID-19 vaccine. He emphasized that vaccination must be put "back on track" after the COVID-19 pandemic. While childhood doses for children aged 0–6 years are largely at pre-pandemic levels, adolescent vaccine rates continue to lag substantially. He surmised that adult vaccination rates are also down. The fall seasonal

²³ More information about Shots Heard Round the World is available at <https://www.shotsheard.org> (accessed November 5, 2020).

influenza vaccination season could provide an opportunity to help restore vaccinations to typical levels, but this will be contingent on parents and families trusting health care providers to provide a safe experience to reduce the risk of contracting COVID-19. He noted that not all providers are clearly communicating the safety measures they are taking and why it is safe to get vaccines from them. Having spent years working on improving seasonal influenza vaccination rates in children and adults, Leask said she hopes that a COVID-19 vaccine will lead to lasting improvement in seasonal influenza vaccination rates. She predicted that communities and governments will likely be motivated to have high vaccination coverage in order to return to pre-pandemic life. Flasche pointed out that in many parts of the world, especially in areas where COVID-19 has had a large impact, there is no seasonal influenza vaccination program. In such places the delivery of the COVID-19 vaccine could be useful in creating a mechanism for improving adult vaccination rates over the longer term, but this will require planning, he added.

Policy Interventions

Buttenheim asked for suggestions about policy interventions to promote vaccine coverage. Leask said that federal governments can enact policies to ensure that vaccination systems are well supported financially and structurally. She noted that mandates can be effective and are perceived as major policy levers for federal or state governments, citing an article by Saad Omer and colleagues on COVID-19 vaccine mandates and when they may or may not be appropriate (Mello et al., 2020; Omer et al., 2019). Additionally, policy makers can create national registries. For example, in Australia, extending the national registry for vaccination of children to a lifelong registry equipped vaccine providers with more data. Consistently logging vaccines each time they are administered to adults enables health care providers to know whether the patient they are seeing is fully vaccinated or not, and it provides a mechanism for reminding them. Therefore, Leask asserted that registries and multifactorial programs to improve coverage, including support and perhaps even incentives for providers, are potential policy levers.

Brewer highlighted several features of effective vaccination programs that ought to pertain to a vaccination campaign for COVID-19: vaccines should be free, safe, available, and easy. Vaccines should be entirely free, because even a small copay is a disincentive for people to act. Secondly, the settings where people receive vaccines must be made completely safe, with transparent social distancing and other safety measures so people do not fear exposure while receiving the vaccine. The third aspect is availability; people need to understand how and when they can access the vaccine once it becomes available. Furthermore, Brewer emphasized that vaccination must be made easy to access through a system that is as user-friendly as possible.

The capacity of primary care may be overwhelmed by handling vaccination for an entire country, so he suggested that pediatric vaccines be provided through pediatricians, then additional options for adults should be explored. He also suggested using the existing infrastructure for vaccines that has already been developed by CDC.

Bettinger described the mandate lever as a “very blunt instrument.” Although they can be effective, mandates can also cause backlash. She suggested that prior to deploying the mandate option, efforts should be made to strengthen immunization systems and offer compensation for providers to adequately deliver vaccines. Brewer cited an article that provides guidance about when and under what conditions to require vaccines (Omer et al., 2019). He contended that many factors would need to be in place before a mandate is instituted, including vaccine availability and measures to ensure equity. Brewer stated that it could be “disastrous” to mandate vaccination in the United States before first setting up the proper infrastructure.

Reflections on Session 2

The second session of the workshop concluded with reflections from Matthew Zahn, medical director at the Orange County Health Care Agency’s Division of Epidemiology and Assessment, and Walter Orenstein, professor at Emory University and associate director of the Emory Vaccine Center. Orenstein remarked, “Vaccines do not save lives; vaccinations save lives.” He contended that substantial resources are needed not only for vaccine development research, but also for vaccine implementation research.

Zahn noted that the dengue vaccine controversy in the Philippines illustrates the value of accurate messaging and providing the public with information on the front end to help families understand the risks of vaccines and shape public perceptions toward vaccine uptake. Orenstein added that when the COVID-19 vaccine is rolled out, serious adverse events will occur that may be either causally or coincidentally related to the vaccine. Therefore, researchers should prepare in advance to evaluate such events for causality and plan the communication strategy to address such concerns when they do occur.

Zahn remarked that gaps in immunization coverage should not be automatically attributed to vaccine hesitancy. To ensure that communities are well served by immunization systems that make it as easy as possible to get vaccinated, it is important to measure immunization rates at the community level. Orenstein added that broader, national level immunization estimates can be misleading because they miss substantial pockets of underimmunization. Detecting underimmunized subpopulations can illuminate how financial and access barriers contribute to low immunization coverage, thus highlighting the need for these barriers to be addressed when designing

immunization systems. Zahn said that the COVID-19 pandemic has led to greater outreach efforts to ensure people are informed about symptoms and the available options for getting tested. He noted this outreach work could be translated into addressing the vaccination and other health needs of specific communities, including racial or ethnic subgroups and people experiencing homelessness.

Referring to the spectrum of vaccine hesitancy, Zahn remarked on the importance of reaching out to communities around the world to learn about their perceptions, concerns, and community-specific opportunities and challenges. Given the crucial role of provider recommendations in influencing people to get vaccinated, Zahn underscored the need for providers to communicate a clear and consistent message to their patients. Orenstein said that direct sources of immunization information may be useful, but most studies have shown that primary care providers are often the most trusted source for vaccination information. Quoting a former director of communications of the U.S. Immunization Program, Orenstein said, “You need the right message delivered by the right messenger through the right communications channel.”

5

A Systems Approach to Increasing Vaccine Confidence and Uptake: Opportunities in Research, Communication, Legislation, and Technology

The third session of the workshop focused on how a systems approach can be employed to build vaccine confidence and increase uptake. The objective of the first half of the session was to explore opportunities in research, communication, legislation, and technology in influencing vaccine behavior, improving access, and building confidence in immunization practices. Dorit Reiss, professor of law at the University of California Hastings College of the Law, presented on legal approaches to promoting parental compliance with childhood vaccines. Michelle Mello, professor of law and medicine at Stanford University, explored lessons learned from California's elimination of nonmedical vaccination exemptions. Dan Carucci, global medical director at McCann Health, presented on the Immunity Charm project, which harnessed cultural insights to promote vaccination. Todd Wolynn, chief executive officer at Kids Plus Pediatrics, presented on the role of physicians in building vaccine confidence and countering anti-vaccine attacks. Sean O'Leary, associate professor at the University of Colorado Denver, presented on strategies for health care providers to engage with vaccine-hesitant parents using face-to-face communication, participatory conversations, and motivational interviewing. The panel was moderated by Chandy C. John from the Indiana University School of Medicine.

LEGAL APPROACHES TO PROMOTE PARENTAL COMPLIANCE WITH CHILDHOOD VACCINES IN THE UNITED STATES

*Presented by Dorit Reiss, University of California
Hastings College of the Law*

Reiss provided an overview of legal approaches to promote parental compliance and increase access to vaccines to help improve childhood vaccination rates in the United States. She discussed existing immunization laws, the state of children's rights with regard to vaccines, legal tools for immunization coverage and school mandates, and the role of government in regulating against misinformation.

Existing Immunization Laws in the United States

Reiss described the interplay of existing federal- and state-level immunization laws in the United States. The U.S. federal government's role in promoting vaccination rates is primarily a supportive and enabling role rather than coercive. The federal government does not—and likely could not—mandate vaccination, but it currently plays several roles in increasing vaccination rates. Although the Commerce Clause is one of the tools used by the federal government to regulate public health, it probably would not allow for a federal childhood vaccine mandate. The federal government can use spending power to encourage state-level vaccination mandates, but such incentives must not be coercive within established limits. Reiss described three roles that the federal government plays in promoting vaccination: (1) increasing access to vaccines for families through the Vaccines for Children Program;¹ (2) setting vaccine schedules, recommendations, and messaging; and (3) ensuring informed consent through vaccine information statements, which are official documents that establish information about vaccines for use by other entities.

Reiss explained that the power to regulate vaccine compliance in the United States primarily lies with the states. States have broad leeway to use the law to increase vaccination in ways that are not being optimally leveraged, however. States have broad regulatory power in the area of childhood vaccines because vaccination lies at the intersection of two plenary powers of the state—police powers and the *parens patriae* doctrine. The police power of states to regulate public health has been acknowledged since before the 19th century. The power of states to regulate child vaccination is further affirmed by states' *parens patriae* power, which gives states the power to pro-

¹ More information about the Vaccine for Children Program is available at <https://www.health.pa.gov/topics/programs/immunizations/Pages/VFC.aspx> (accessed October 9, 2020).

tect the vulnerable. The combination of these powers creates a strong legal sphere, she noted. States have primarily regulated childhood vaccination through school immunization requirements and adult vaccination through workplace immunization requirements, but Reiss emphasized that states have many other tools available.

Children's Rights and Childhood Vaccines

In more than 100 years of contentious jurisprudence on the issue, Reiss pointed out that no state or federal court has ever struck down an immunization mandate. When U.S. courts evaluate school immunization mandates and other vaccination laws, they use a framework to balance various rights and interests including parental autonomy, children's rights, the individual rights of others, and overall community health. With respect to parental autonomy, courts recognize that parents have the right to make decisions in the interest of their child. Given the relatively favorable risk/benefit trade-offs associated with vaccination, she noted a strong argument can be made in favor of children's right to be vaccinated to the fullest extent medically possible. Additionally, the rights of individuals may be infringed upon if they are infected by an unvaccinated child who contracts a preventable disease. These considerations are bolstered by the states' extensive power to take action to prevent the spread of disease. Together, these considerations are balanced against the consideration of parental autonomy alone. She said that in the eyes of the court, a parent's resistance to vaccination puts not only their child but the community in general at risk, which is not a strong position. In this sense, the rights of other families' interests, the child's rights, and public health can outweigh parental autonomy.

Reiss considered whether the right to religious freedom tips the balance of these considerations. She described two reasons that rights of religious freedom are not barriers to childhood vaccination regulations. First, under Supreme Court jurisprudence, a mutually generally applicable law is not required to have a religious exemption. Because school immunization requirements are generally applicable (i.e., they do not target members of particular religions), they are not required to have religious exemptions. Second, the legal consideration of religious freedom rights is reduced in matters related to children because children do not make their own decisions. Parents cannot use their rights of religious freedom to put their children and others at risk.

School Immunization Mandates and Requirements in the United States

States have a broad set of actions at their disposal to help increase vaccination rates, but Reiss said school immunization mandates are the most

commonly used throughout the United States because they are legally sound and effective. School immunization mandates have been used in the United States since at least the 19th century, and every state currently has school immunization requirements. Reiss explained that some states offer medical exemptions only; some offer medical and religious exemptions only; and some offer medical, religious, and personal belief exemptions. As of August 2020, just five U.S. states offered only medical exemptions: California, Maine, Mississippi, New York, and West Virginia. Other states are considering such a policy but have not yet passed legislation. Every other state allows some degree of nonmedical exemptions on the basis of personal beliefs or religious beliefs, although the ease of obtaining such an exemption varies between states.

Reiss noted that many of the other tools available to states are less coercive than school immunization mandates, which limit access to schooling based on children's immunization status. To explore options for broadening the scope of state-level activities in this domain, she presented the suite of legal tools for promoting vaccination on a continuum of coerciveness. Progressing from most coercive to least coercive, these tools include use of force, criminal law, conditioned access, cost internalization, mandated transparency, procedural tightening, positive incentives, and persuasion through education. Reiss said that many schools report data on immunization rates, but few states require schools to do so. Colorado has adopted a moderate vaccine policy that requires schools to send school immunization rates to parents. This policy is less coercive toward the individual parent, but it may help parents make informed choices. Laws that impose tort liability when non-vaccination causes harm are an example of a less directly coercive mandate available to states. Similarly, increasing access to immunizations through laws that allow minors to make their own vaccination choices is another non-coercive approach.

The Government's Role in Regulating Against Misinformation

Reiss described opportunities for government action that could help curb disinformation around vaccines. The government has broad powers for messaging and making recommendations,² but its power to regulate speech is limited by the right to freedom of speech granted by the First Amendment of the U.S. Constitution. However, this right is not absolute, and speech is in fact regulated constantly. For instance, commercial speech is widely regulated. Demonstrably false commercial speech can be and is prohibited

² Reiss suggested that the government could better use these powers. For instance, government bodies could make statements about vaccine safety oversight during COVID-19 vaccine trials.

by the federal government. Furthermore, many states have consumer protection acts that regulate misinformation in both the commercial and nonprofit sectors. Thus, false information can, in theory, be regulated regardless of whether it comes from the commercial sector or not. *Central Hudson Gas & Electric Corporation v. Public Service Commission of New York*³ is the central leading case in public health about prohibiting speech, and it holds that false or misleading speech is not protected. However, Reiss pointed out this precedent is not as strong as it seems. First, there are risks involved in allowing government to directly arbitrate the truth of potentially misleading speech, because speech can be misleading in subtle ways. For instance, the National Vaccine Information Center, an anti-vaccine organization, posts the number of reports in the Vaccine Adverse Event Reporting System (VAERS) for every vaccine. These posts are truthful, but they can be misleading in that the VAERS reports are not sufficient to establish causation and do not necessarily reflect vaccine risk. Therefore, this type of speech is misleading, but it is not quite untruthful. Reiss described this example as highlighting the limits of the government's power to regulate misinformation by acting only against false statements.

IMPACT OF ELIMINATING NONMEDICAL EXEMPTIONS IN CALIFORNIA

Presented by Michelle M. Mello, Stanford University Law School

Mello explored the effect of California's elimination of nonmedical exemptions within its school immunization mandate. She discussed the nature of California's legislation, the effects of California's new exemption laws, and lessons learned from California's experience that may inform other states pursuing such legislation.

Changes to California Immunization Exemption Laws (2014–2021)

Changes to California's vaccination law have been unfolding gradually since 2014. Prior to then, Mello explained, California had a personal belief exemption that also incorporated religious belief exemptions. Assembly Bill (AB) 2109, which went into effect January 1, 2014, was aimed at reducing the use of these exemptions by imposing certain procedural requirements for obtaining them. The bill required that parents submit a health care provider's testimony that the parent was counseled about the risks and benefits of the

³ More information about *Central Hudson Gas & Electric Corporation v. Public Service Commission of New York* is available at <https://www.oyez.org/cases/1979/79-565> (accessed October 12, 2020).

relevant immunizations and communicable diseases when submitting their personal belief exemptions to the California Department of Public Health. This change did not successfully bring about a substantial decrease in exemptions, so the legislature subsequently adopted a stronger policy. Senate Bill (SB) 277, passed in 2015 and effective as of January 1, 2016, eliminated California's personal belief exemption, making medical exemptions the only permissible basis for forgoing required vaccines. Mello said that SB277 allowed these exemptions to be written by any licensed physician for any medical reason, including simply "family medical history," because the bill did not require that a specific medical reason be cited. SB277 applied to students in public and private elementary and secondary schools, day care centers, and youth development centers. However, it did not apply to students attending home-based private schools, students enrolled in independent study programs with no classroom instruction, or students with individualized education programs who would be barred from accessing related services. The bill also allowed children with personal belief exemptions filed within 6 months of the bill's passage to continue in school until the next grade span began (e.g., kindergarteners could continue until seventh grade). These loopholes resulted in a substantial number of children obtaining exemptions. The legislature responded again, passing SB276 in 2020. Effective as of January 1, 2021, SB276 tightens the conditions under which medical exemptions can be written (see Box 5-1).

Effect of California's Changes to Immunization Exemption Laws

The impacts of these bills have been well studied, said Mello (Delamater et al., 2019, 2020; Mohanty et al., 2018). These effects can be categorized into three groups: (1) effects on the any-exemption rate; (2) effects on the percentage of kindergarteners who are fully up to date on required vaccinations; and (3) effects on the rate of medical exemptions. Projections of the overall impact of SB277 and SB276 between 2015 and 2027 suggest that SB277 alone would decrease the number of children with any exemption from 2.59 percent to 1.87 percent during that period; the addition of SB276 is expected to further reduce the any-exemption rate to 1.41 percent by 2027 (Delamater et al., 2020). The authors of that analysis concluded that overall, SB277 had a modest effect on exemption rates. In the 2 years following the passage of SB277 in 2015, the percentage of up-to-date kindergarteners increased from 92.8 percent to 95.1 percent. Mello said that the increase in the percentage of up-to-date kindergarteners is a key effect of this legislation, because it has put the state over the threshold for herd immunity to measles, which has been a major issue in California since 2015. Still, the rates of medical exemptions had increased fourfold in the state in 2019, 4 years after SB277 was passed. Although the exemption rate among children in Califor-

BOX 5-1
Exemption Provisions Under California's Bill SB276

- Requires physicians to submit medical exemptions to the California Department of Public Health's immunization registry on a standard form
- Requires the submitting physician to certify under penalty of perjury that statements in the form are true and that he or she has physically examined the child
- Requires that if the submitting physician is not the child's primary care physician, the submitting physician must state how long she or he has been treating the child, identify the primary care physician, and explain why the primary care physician is not making the submission
- Requires that children with preexisting medical exemptions must follow the new procedures in order to maintain their exemption
- Requires the California Department of Public Health to annually review exemption requests to identify schools with immunization rates of less than 95 percent and physicians who have submitted more than four exemptions in 1 year and to review all exemption forms identified through this process
- Authorizes the California Department of Public Health to revoke exemptions that are deemed inappropriate because they do not meet the U.S. Centers for Disease Control and Prevention Advisory Committee on Immunization Practices or the American Academy of Pediatrics exemption criteria and grants parents the right to appeal such decisions
- Requires that the California Department of Public Health report physicians whose exemption-related practice is "contributing to a public health risk in one or more communities" to the state medical board

SOURCE: Mello presentation, August 19, 2020.

nia was low (0.2 percent) in 2015, it represents a large relative increase if not a large absolute increase. This increase in exemptions was concentrated among a small number of physicians, which has raised concerns about the validity of medical exemptions. A small number of medical providers seem to be offering exemptions widely, and there is some concern that certain physicians (especially those not in relevant specialties) may be selling these certifications through Internet outreach. Mello noted these were among the concerns that motivated the passing of SB276.

Review of the Effect of State Vaccination Exemption Laws

Mello highlighted four conclusions from a systematic review of research on the effects of state vaccination exemption laws (Wang et al., 2014). First, states without nonmedical exemptions have lower rates of vaccination exemptions and vaccine-preventable diseases than states with such exemp-

tions. Second, the ease of obtaining exemptions is associated with higher exemption rates and disease outbreak risk. California's experience with the physician counseling requirement notwithstanding, this suggests that the imposition of additional paperwork, for instance, should have an effect on risk of outbreak and exemption rates in a state. Third, even though the overall reductions in exemption rates may be modest in absolute terms, small reductions in exemption rates translate into large numbers of additional children vaccinated. For instance, if the projected reduction in exemptions in California are realized, reducing to 1.41 percent by 2027 (Delamater et al., 2020), that would result in an additional 84,000 children being up to date in their vaccinations. This would have a large effect, she said, especially considering that exempted children are not evenly distributed geographically across California. Rather, the areas with initially high localized exemption rates would see the most substantial improvement. Prior to the passage of SB277, approximately one-quarter of California's kindergartens had immunization rates too low to achieve herd immunity for highly infectious diseases such as measles. This, she pointed out, demonstrates the critical importance of even small decreases in exemption rates. Fourth, if vaccination exemption laws leave open avenues for avoiding vaccination, parents opposed to vaccination will always find ways to do so.

Lessons Learned from California's Experience

Mello described lessons learned from California's experience in eliminating nonmedical exemptions. Chief among these is the importance of avoiding loopholes and large compromises in the scope of the law. For example, SB277 was passed with a grandfather clause that allowed parents to get exemptions for their children during a 6-month period after the passage of the law, which did not go into effect for nearly 1 year after its passage. This gave parents a substantial opportunity to avoid the law's intended effect. Mello recommended that other states avoid such grandfather clauses. Additionally, SB277 allowed physicians to write medical exemptions for any reason, rather than exclusively requiring a valid and recognized contraindication to vaccination. Mello recommended that other states limit the basis for a medical exemption to only valid, medically recognized contraindications, rather than allowing for vaguely articulated reasons such as "family history." California also initially allowed medical exemptions to be written by any health provider, regardless of their history with the child or their relevant expertise on vaccination. SB276 attempted to address some of these issues, but it was too late to address the challenges associated with the grandfather clause in SB277. Even now, California law does not require that the exemption be written by a child's primary care physician; it merely imposes an additional explanation when the exemption is written by a physician

other than the child's primary pediatrician. Instead, Mello explained, states should require that medical exemptions come from a pediatrician or family physician who the child sees for regular care. Mello added that it is not clear what the California Department of Public Health is going to do with information collected about why a physician other than a child's pediatrician has submitted a child's exemption.

Mello shared additional lessons that are relevant to other states pursuing this approach. Other states have chosen to adopt incremental legislation, despite the obvious flaws in this approach as exemplified by the shortcomings of SB277. She suggested that through these incremental bills, legislators may be hoping to first demonstrate that tightening exemption policies is effective for increasing vaccination before passing additional laws to address the flaws and loopholes in their initial policies. In Mello's opinion, this approach is misguided because those who resist the initial laws are unlikely to be convinced or cease their efforts to resist vaccination upon seeing the effectiveness of the incremental policies. The opposition to tightening vaccination exemptions is likely to remain, so passing subsequent updates to exemption policies will likely be as difficult as passing initial incremental policies. She noted that there was great resistance to the passage of SB276, which culminated in an incident where anti-vaccination activists threw human blood onto the Senate gallery while the bill was being debated and physically assaulted one of the bill's proponents. Mello said that this incident is an example of why exemption-tightening bills should be designed in a way that makes them more likely to be effective. She advised that states seeking to reduce vaccination exemptions should address the appropriate details from the outset to preclude the need for further legislation. States should also expect anti-vaccination groups to mobilize to help parents take advantage of loopholes in new requirements.

Mello also shared some aspects of California's approach that serve as useful models for other states' exemption-tightening policies (Mello, 2020). California's legislation is broad in scope, eliminating all nonmedical exemptions and creating evenhanded rules that apply to private schools and day care centers, not just public schools. Additionally, California set forth a specific but comprehensive list of required immunizations.⁴ She suggested that states follow California's lead in including provisions in their legislation that require annual data on school-level exemption rates to be made public. Such provisions empower parents to pressure schools and health departments to remain vigilant in enforcing exemption policies. Finally, Mello recommended

⁴ Mello contrasted this approach with that used by Washington State, where legislators focused on the measles, mumps, and rubella vaccine during a measles outbreak. She pointed out that because of the narrow scope of its law, Washington legislators will face the same issues and challenges again whenever an outbreak of another vaccine-preventable disease occurs.

that states' exemption-tightening policies task departments of health (rather than schools) with reviewing medical exemptions, and that departments of health be empowered to take action against "frequent flyers" (i.e., physicians who write a large number of exemptions).

HARNESSING CULTURAL INSIGHTS TO INCREASE VACCINATION UPTAKE

Presented by Daniel Carucci, McCann Health

Carucci discussed the Immunity Charm project as an example of how cultural insights can be harnessed to increase vaccination uptake. The project was developed by McCann Health in its efforts to increase vaccine uptake as part of its commitment to apply its expertise in marketing and advertising to efforts to increase the impact of global health investments. He noted that McCann's work on vaccination has focused on the demand side, developing creative ways to drive vaccine uptake in underserved and underdeveloped parts of the world. The development of the Immunity Charm project began when McCann Health was working with the Afghanistan Ministry of Public Health through a United Nations Children's Fund (UNICEF) program to improve health communication strategies across the country through ministry programs.

Drivers of Underimmunization and the Need for Increased Vaccine Demand

Carucci spoke on the benefits of childhood immunizations and the potential for further improvements. Vaccines save the lives of an estimated 2–3 million children each year worldwide, but higher immunization rates could save the lives of an additional 1.5 million children if they received the vaccines they need and completed their full vaccine schedule.⁵ Although national statistics show improving vaccine coverage, there remain large regional coverage gaps. He remarked that "childhood immunizations ... are arguably one of the most powerful and effective health interventions we have to reduce childhood mortality."

Carucci presented an analysis of factors driving underimmunization, which he categorized as either access-related factors or demand-related factors. The five factors reducing access include lack of supply, poor distribution chain, conflict areas, inaccessibility, and poor logistics. He acknowledged

⁵ More information about how vaccinating the world's children can save 1.5 million lives is available at <https://www.unicefusa.org/stories/how-save-15-million-lives-year-vaccinate-worlds-children/31793> (accessed October 13, 2020).

that international organizations such as UNICEF and Gavi, the Vaccine Alliance, have helped improve vaccine coverage with efforts that have increased access to vaccines. Despite these improvements, lack of access remains a factor in preventing children from receiving the vaccines they need, especially issues related to supply chains, distribution chains, logistics, and other technical problems. He noted that large regional gaps in immunization coverage remain even in settings where vaccines have become more accessible. These regional gaps may be attributable to lack of demand, because far too many parents fail to appropriately prioritize their children's vaccinations. He listed five factors that suppress parental demand for childhood immunization: myths, misperceptions, indifference, ignorance, and illiteracy. He suggested that many parents do not bring their children to clinics for vaccination on the appropriate schedule largely because of these demand-related factors.

In areas where access is not a primary driver of underimmunization, increasing demand is critical for improving vaccination uptake and compliance. Carucci discussed underimmunization as a demand-driven problem that can be addressed by considering how young mothers perceive the value of childhood vaccinations. Young mothers often struggle with many life stresses, and their children's vaccinations are often not prioritized. Mothers must choose to devote substantial time and resources to have their children vaccinated, but they will not make that choice unless they see immunization as a high priority. Carucci emphasized that a compelling and emotional message is needed to show mothers that vaccines are necessary to protect their children from serious illnesses so that they can grow up to be strong and healthy.

Increasing the Perceived Value of Childhood Vaccines with the Immunity Charm

Throughout South Asia, a simple bracelet is used as a symbol of protection against evil spirits, Carucci explained. Mothers and grandmothers often provide these bracelets to their children in early infancy, often adorned with a *nazar* (i.e., evil eye) charm as an additional form of protection. These bracelets can be found across socioeconomic classes and educational levels not only in South Asia, but in other communities as well, such as in Africa. Based on this cultural practice, McCann Health created the Immunity Charm, a bracelet that has the potential to increase vaccination uptake and compliance, potentially saving millions of children's lives each year. In developing the project, they sought to associate existing cultural symbolism—bracelets as powerful symbols of protection against unknown forces—with the protection afforded by vaccines against serious disease. The Immunity Charm is a bracelet made of black thread with a screw closure; it comes preloaded with a *nazar* charm and a series of black beads (see Figure 5-1). Colored beads

representing each of the vaccines associated with the World Health Organization's (WHO's) Expanded Program on Immunization are added to the bracelet at the time of immunization.⁶ Thus, the Immunity Charm is also an immunization history that is worn by the child, and each new colored bead represents an additional level of protection against disease.

Response to the Immunity Charm Project

McCann conducted a small qualitative project in Kabul to assess the acceptability of the bracelet among health care staff and mothers attending a vaccine clinic, said Carucci. His team found that the bracelet was readily acceptable to mothers and health care workers at the immunization clinic. In fact, the bracelets were so popular that McCann encountered difficulties securing sufficient inventory. He reported that the overall response to the Immunity Charm was overwhelmingly positive from both health care providers and mothers; he also shared testimonials from some of the providers interviewed. Health care workers reported that the Immunity Charm fit into the existing traditional belief systems of their community and felt confident that the bracelet could be a driver of mothers' appreciation for the role of vaccines in protecting their children. One health care worker remarked that he overheard mothers discussing which colored bead represented which vac-



FIGURE 5-1 Immunity Charm bracelet.
SOURCE: Carucci presentation, August 19, 2020.

⁶ The Immunity Charm includes a colored bead for measles doses 1 and 2, oral polio vaccine doses 0 through 4, pneumococcal conjugate vaccines doses 1 through 3, pentavalent vaccine doses 1 through 3, and hepatitis B vaccine. More information is available at <http://www.theimmunitycharm.org> (accessed May 20, 2021).

cine. This health care worker said that they had never experienced mothers talking about vaccines in this way.

Potential Impact of the Immunity Charm Project

McCann Health sees the Immunity Charm as a potentially powerful driver for improving uptake in vaccine compliance in particular communities where this tradition is widespread, said Carucci. He suggested that the bracelet could drive vaccine compliance in three distinct ways. Mothers see the Immunity Charm as a symbol of protection against disease, in the same way that they see other bracelets as symbols of protection. Additionally, the bracelet serves as a symbol of a mother's love for her child and of good mothering, thus increasing the perceived value of vaccines among mothers. For the community, the bracelet serves as a visible signal to other influential mothers and community members, thus encouraging other mothers who have not yet vaccinated their children to do so. For health care workers, the bracelet provides an additional and readily visible indication of a child's immunization status, particularly if the official immunization record is not available. However, Carucci emphasized that the Immunity Charm is not intended to replace the standard immunization card. Carucci said that to build on this qualitative research, his team intends to launch a quantitative effectiveness study in India, although it has been delayed by the COVID-19 pandemic.

THE ROLE OF PHYSICIANS IN BUILDING VACCINE CONFIDENCE AND ACCEPTANCE

Presented by Todd Wolynn, Kids Plus Pediatrics

Wolynn discussed the role of physicians in building vaccine confidence and acceptance. He noted that perceptions of infectious diseases, physicians, and the field of medicine have all evolved over time. In the past, trust in physicians and the medical system was fairly high, but this began to decline by the beginning of the 21st century. He attributed this change, in part, to the increasing "businessification" of medicine, which has created a rift between physicians and their patients. Health care systems have become encumbered with administrative burdens, limitations on time spent with patients, increasing managerial meetings, and—at least in the United States—an increasing focus on profiting from health and illness, he said. Furthermore, health care providers have begun to lose their ability to communicate effectively with the families that they serve and are at risk of losing one of their most precious assets: a close and trusted longitudinal relationship with patients. He remarked that in addition to these changes in the health systems, providers

were also unaware of new and potentially devastating threats to public health that have emerged in the form of fake news, conspiracy theories, and pseudoscience. Vaccines have long been attacked by skeptics, but new digitally fueled disinformation and weaponized anti-vaccine attacks are rapidly eroding vaccine confidence, he cautioned. Because they are generally ill-equipped to address the challenges of these anti-vaccination forces, many health care providers have begun to lose confidence in their own ability to influence and help the populations they serve, he suggested.

Forces of Vaccine Hesitancy

Wolynn discussed the forces that act on vaccine hesitancy, explaining that approximately 75 percent of the U.S. population is vaccine accepting, 23 percent is vaccine hesitant, and 1–2 percent are anti-vaccine. Traditionally, discussion of vaccines usually took place only in health care settings. Today, however, millions of discussions about vaccines are taking place online each day on social media, including relentless aspersions against the safety, effectiveness, and necessity of vaccines. These messages can have great effect through the tendencies toward tribalism often observed on social media, he noted. For instance, a person may be more likely to believe content that has been posted by a fellow group member on a social media platform even if they have never met in person.

In a recent paper that evaluated the online competition between pro-vaccine and anti-vaccine views, the authors noted that anti-vaccine groups are growing quickly and are on pace to outgrow pro-vaccine groups (Johnson et al., 2020). Even seasoned physicians are often unprepared to address vaccine hesitancy in person, instead responding to vaccine hesitancy with fear tactics or data. Wolynn suggested that such responses from physicians can unwittingly push vaccine-hesitant families toward becoming further entrenched in their vaccine skepticism. Furthermore, many young physicians are entering the health care system with their own uncertainties about vaccines and may capitulate with families' requests to delay or skip vaccinations. This kind of capitulation has a deleterious effect on the public perception of the importance of vaccines. Many physicians lack formal training in communication, active listening, and face-to-face engagement. Additionally, there is essentially no plan to develop training for physicians on how to communicate with patients when interacting virtually.

Unfortunately, the trust network that exists between millions of physicians, health care providers, and their patients is not being adequately used against vaccine hesitancy because of a lack of training and support from institutions, he said. These trusted relationships are at risk while the information vacuum is being filled by other actors who are more willing to listen and provide information, he warned. Fortunately, there are strategies that can be

implemented to address both the virtual and face-to-face forces contributing to vaccine hesitancy.

Communication Methodology for Building Vaccine Confidence

Wolynn presented a face-to-face communication methodology called AIMS (announce, inquire, mirror, and secure), developed by John Parrish-Sprowl and Angus Thomson,⁷ that can be used by health care providers who encounter vaccine hesitancy. This method, which focuses on using powerful active listening and communication skills to build a trusting relationship, involves four components: announce, inquire, mirror, and secure. The “announce” component of the approach capitalizes on the fact that approximately 75 percent of the U.S. population are already willing to accept vaccines, in that the provider makes a presumptive announcement to raise the topic of vaccines and with these patients they are not met with hesitancy. Inquiring and mirroring are features of active listening, a strategy that is particularly useful when engaging with parents who are vaccine hesitant. People need to feel that they are being heard and that the physician is on their side and understands their concerns. This process facilitates a meaningful conversation that can help encourage many people to choose to vaccinate, said Wolynn. The methodology also recognizes that some patients will choose not to vaccinate. In those situations, the provider focuses on the fourth component: securing the relationship between health care providers and their patients and establishing trust. Providers can secure this relationship with statements such as “Maybe we will not give all the vaccines I’ve recommended today, but we can discuss that next time.” The AIMS approach is not only effective for face-to-face interactions but also for busy health care settings that have relatively few vaccination-related interactions with patients.

Countering Anti-Vaccine Attacks

Wolynn noted that millions of conversations about vaccines occur online, with those who promote vaccines or call out disinformation at risk of being attacked. These attacks are designed to overwhelm, isolate, weaken, frighten, terrorize, cause damage, dissolve, and silence. They can be vicious and severe, leaving many victims feeling traumatized by the experience. While only 1–2 percent of the U.S. population is thought to be anti-vaccination, this group is disproportionately influential because there is a globally coordinated network that is working tirelessly, strategically, and effectively to promote anti-vacci-

⁷ More information on the AIMS approach applied to conversations on vaccination is available at <https://www.fondation-merieux.org/wp-content/uploads/2017/01/vaccine-acceptance-2017-john-parrish-sprowl.pdf> (accessed May 20, 2021).

nation messages, he said. For instance, quaternary health systems have been shut down for fear of attack by anti-vaccination groups after posting about influenza vaccination as flu season approached. Providers and clinics have no instructions on how to deal with virtual attacks, no organized groups of allies to provide aid, and anti-vaccine attacks are extremely effective.

Wolynn shared the story of how an anti-vaccine attack on his practice led to his own research on effective counterattacks. In August 2017, his practice, Kids Plus Pediatrics, produced a 90-second public service announcement on the power of the human papillomavirus (HPV) vaccine in preventing cancer. One month later, his practice suffered a coordinated, week-long, global attack on its social media and online ratings pages. To combat these types of attacks, Wolynn and colleagues published an article on anti-vaccination campaigns and the 2017 attack on their practice (Hoffman et al., 2019). They created a toolkit and described how they organized a “digital cavalry” of nearly 900 people in 20 countries to launch an international awareness campaign. This campaign was aimed at teaching, uniting, strengthening, empowering, defending, recovering, emboldening, and galvanizing pro-vaccine health care providers on social media. These methods directly counter the attacks employed by anti-vaccine groups. Wolynn remarked that when confronted with science and data, anti-vaccination advocates and online bullies moved on to softer targets.

This experience led to the creation of Shots Heard Round the World, a rapid-response network dedicated to combating anti-vaccine attacks on the social media pages, web sites, and review sites of providers, practices, hospitals, and health systems.⁸ Wolynn said that for some people who have experienced these types of attacks, the Shots Heard network has helped to strengthen and empower them to become highly effective advocates. The original toolkit is being revamped and will be available in English, French, Portuguese, and Spanish. Shots Heard Round the World has partnered with Stronger, a national campaign aimed at stopping the spread of harmful misinformation about science, medicine, and vaccines by sharing correct information and arming people to fight back against misinformation.⁹

Strategies for Vaccine Advocacy

Wolynn emphasized that the battle between vaccine hesitancy and vaccine confidence spans both face-to-face and virtual communication, that there are ways to address both, and that effective communication can be

⁸ More information about Shots Heard Round the World is available at <https://www.shotsheard.org> (accessed October 13, 2020).

⁹ More information about Stronger is available at <https://www.stronger.org> (accessed October 13, 2020).

strengthened through appropriate training. He noted that it is exceedingly difficult to debunk misinformation once it has taken hold. To that end, the University of Cambridge has begun efforts to “prebunk” COVID-19 conspiracies by providing accurate information about vaccines before conspiracy theories begin to spread.¹⁰ This kind of activity has been shown to make individuals more resistant to being affected by disinformation. To promote vaccination and leverage their trusted relationships with patients, health care providers would benefit from improved communication training in medical school, residency, nursing school, public health education, and other educational settings, he added. Moreover, advocates of vaccination should work collectively to promote vaccines (e.g., through inoculation with facts), undermine disinformation campaigns, and defend against weaponized social media attacks.

COMMUNICATING WITH VACCINE-HESITANT PARENTS

Presented by Sean O’Leary, University of Colorado School of Medicine

O’Leary described various strategies that health care providers can use to communicate with vaccine-hesitant parents using face-to-face communication, presumptive conversations, and motivational interviewing. Although his presentation focused on effective communication in patient–provider encounters, he emphasized that patient–provider communication is only one strategy among many that need to be implemented simultaneously to achieve and maintain high vaccination coverage.

Impact of Provider Vaccine Recommendations

O’Leary emphasized the effect of recommendations from a health care provider in shaping parents’ attitudes toward vaccinating their children. Providers should recommend vaccines as part of their communication strategy with vaccine-hesitant parents because the quality and presence of a provider’s recommendation have consistently been associated with increased uptake of vaccines. This is consistent with polling data indicating that medical providers are among the most trusted individuals in society.¹¹

¹⁰ More information about the University of Cambridge’s efforts to prebunk COVID-19 conspiracies is available at <https://www.cam.ac.uk/stories/goviral> (accessed October 13, 2020).

¹¹ More information about Gallup’s ranking of honesty and ethics in professions is available at <https://news.gallup.com/poll/274673/nurses-continue-rate-highest-honesty-ethics.aspx> (accessed October 8, 2020).

Continuum of Vaccine Acceptance

Providers should adapt their communication strategy based on where a parent is situated along the continuum of attitudes toward vaccines, said O’Leary. On the pro-vaccine end of the spectrum are vaccine acceptors (about 70 percent of the population), in the middle are those who are varying degrees of vaccine hesitant (around 30 percent of the population), and on the anti-vaccine end are vaccine rejectors (less than 1 percent of the population). Figure 5-2 provides more detail about common attitudes expressed by each of the three groups. Even though vaccine rejectors are often vocal, they make up an exceedingly small proportion of the population, he noted. O’Leary suggested using strategies for vaccine communication with parents who accept vaccines and those who are hesitant about vaccines but not with a parent who is determined to reject vaccines. Parents who would try to convince a provider that vaccines are bad will probably not be convinced to accept vaccines in a single patient encounter. He advised that when engaging with vaccine rejectors, providers should simply state their belief in the importance of vaccines and offer to keep the dialogue open. Otherwise, these types of encounters can escalate into arguments and leave little time to discuss other health and safety issues.

Evidence Regarding Face-to-Face Communication About Vaccines

O’Leary presented evidence regarding the effectiveness of face-to-face vaccine communication techniques. These have been investigated by two Cochrane reviews in the past decade, both of which determined that evidence for specific techniques is not conclusive. In 2013, a Cochrane review

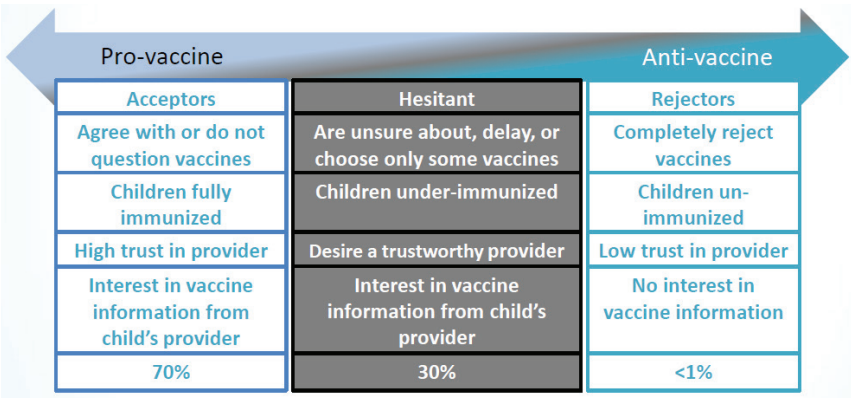


FIGURE 5-2 Continuum of vaccine acceptance.
SOURCE: O’Leary presentation, August 19, 2020.

concluded that the limited evidence available was of low quality and suggested that face-to-face interventions to inform or educate parents about childhood vaccination have little to no effect on immunization status, knowledge, or understanding of vaccination (Kaufman et al., 2013). In 2018, Cochrane published an updated version of the review which found low- to moderate-certainty evidence suggesting that face-to-face information or education may improve or slightly improve children's vaccination status, parents' knowledge, and parents' intention to vaccinate (Kaufman et al., 2018).

O'Leary considered why better evidence about how to communicate about vaccines with parents and patients is not available. While much research has been conducted on parents' and patient's knowledge, attitudes, and beliefs, there has been relatively little research on which communication techniques change behavior. He characterized this research gap as a focus on the *what* rather than a focus on the *how*. He stated that it is still necessary to study the *what* questions: (1) what safety surveillance mechanisms work, (2) what ingredients are used to make vaccines, (3) what diseases are prevented by vaccines, (4) what is the immunology of vaccination, (5) what is recommended by the U.S. Centers for Disease Control and Prevention (CDC) Advisory Committee on Immunization Practices, and (6) what facts address vaccine misconceptions. However, only studying the *what* is not sufficient to address vaccine hesitancy. The *how* questions must also be studied to find the most effective ways to convey information to parents or patients who are already resistant to vaccination so they might become more receptive to the information, he said.

Presumptive Versus Participatory Conversations About Vaccination

Conventional wisdom holds that if providers improve knowledge, patients and parents will make the right decisions, said O'Leary. However, this presumes that human decision making is rational, and that assumption is not always well founded. Thus, investigators have begun to focus on developing interventions to improve vaccination by studying how people actually think rather than how they ought to think.

An observational study performed by investigators in Seattle recorded parent-provider encounters during well-child visits to look for predictors of vaccine uptake (Opel et al., 2013). Parents were told that the investigators were examining communication techniques related to preventive care in children, rather than vaccine communication techniques, so as not to affect the vaccination discussion. Investigators administered a broad survey prior to the visit to identify vaccine-hesitant parents, which allowed the investigators to oversample this population. Of the 111 vaccine discussions recorded, half were with vaccine-hesitant parents.

The investigators found that the best predictor of vaccination uptake for both hesitant and non-hesitant parents was how the providers started the conversation (i.e., the first words uttered by the provider). The study used two conversation formats and found a striking difference in the outcomes associated with each approach. The first approach, the presumptive format, began with a declarative sentence that presupposes that the parents will have their children vaccinated (e.g., “Sara gets three shots today.”). The second approach, the participatory format, begins with an open-ended question that shifts decisional control to the parent (e.g., “How do you feel about shots today?”). When providers opened the conversation in a presumptive format, parents resisted the recommendation about 26 percent of the time. When providers opened the discussion in a participatory manner, parents resisted the provider’s recommendation about 83 percent of the time. This finding held true for both hesitant and non-hesitant parents.

O’Leary considered some of the possible reasons that presumptive conversations were associated with less parental resistance. He noted that when individuals perceive a decision to be complicated—such as when parents face the decision to have their children vaccinated—they tend to be affected by the status quo bias,¹² which is the tendency to do what is expected or appears to be normal. By assuming a presumptive tone, providers convey that vaccination is the normal choice, making parents less likely to resist. In many cases, the presumptive format may make parents more comfortable with their decision to vaccinate, because the participatory format can leave parents questioning whether they have made the correct decision for their child. He added that a randomized controlled trial has confirmed the effectiveness of announcements versus conversations in improving uptake of human papillomavirus vaccination (Brewer et al., 2017b).

Motivational Interviewing

O’Leary explained that motivational interviewing is a technique that provides a framework for communication that reverses the traditional patriarchal approach of medicine—that is, the approach wherein patients are expected to change behavior because of a provider’s guidance. Instead, this framework uses guided conversation that is driven by the patient’s internal motivations. The provider guides the conversation so that the patient recognizes the importance of the behavior change to their own internal motivations. O’Leary endorsed the technique for its adaptability and because it can be used to improve conversations about most topics.

Evidence that this interview technique helps increase vaccine uptake comes from a study that tested the effect of motivational interviewing

¹² The status quo bias is also called the default bias.

training on adolescent HPV vaccination (Dempsey et al., 2018). Clinics were randomly assigned to the control and intervention study arms. The intervention included several components with motivational interviewing training at the center of the intervention. The study found that the self-efficacy for changing parents' minds about HPV vaccine improved among providers in the intervention arm, and time spent in HPV vaccine discussions remained the same or decreased from baseline at 4 months after the training in intervention clinics. Furthermore, there was a 9.5 percent increase in HPV vaccine initiation in the intervention arm versus the control arm.

Motivational Interviewing Skills for Use in Vaccine Conversations

O'Leary described five motivational interviewing skills that can be used for vaccine conversations, but noted that the broader practice of motivational interviewing can involve a longer process than the one used for vaccine conversations. The motivational interviewing process developed for vaccine conversations is intended to be effective but also efficient. Based on provider feedback, O'Leary's team identified five skills that are most important when having discussions about vaccines: open-ended questions, affirmation, reflection, autonomy support, and asking permission to share. Open-ended questions help to explore and understand parents' stance on vaccination. Affirmation improves parent engagement in an open discussion by helping them feel supported, appreciated, and understood. Reflection encourages partnerships, deepens rapport, and allows a parent to understand themselves and their motivations on a deeper level. Autonomy support enhances a parent's sense of control and makes them feel more at ease with the conversation. Finally, asking permission to share puts parents in a less defensive posture and makes them more receptive to information that providers want to share.

O'Leary provided a brief demonstration of these skills through a hypothetical parent-provider encounter (see Box 5-2). The provider's first response to the parent's objection is an open-ended question. Upon hearing the parent's concerns, the provider affirms the concerns and reflects them back to the parent. The provider takes care to ask for permission before offering their view of the HPV vaccine, and finally the provider exemplifies autonomy support by closing the exchange by putting the decisional power in the parent's control.

O'Leary explained that teams in Colorado and Washington State are working to test this technique in a randomized trial in which providers are trained in motivational interviewing for addressing the infant series of vaccines. One experienced pediatrician involved in these trainings reported, "Asking permission to share has been a game changer." She

said that this skill has changed her conversations and that she tries to implement this skill every time she uses the motivational interview technique. O'Leary acknowledged that numerous groups around the world are working with motivational interviewing techniques for vaccination conversations, specifically acknowledging promising results from a study conducted in Canada (Gagneur, 2020). He added that although other potentially effective communication frameworks are available, motivational interviewing is beneficial because it offers providers tools that they can adapt to address many health concerns in a mutually beneficial manner. The motivational interviewing technique lets providers and patients feel that their concerns have been heard, and it leaves providers feeling confident that they can communicate the facts without drawing patients into an argument.

BOX 5-2

Example of Motivational Interviewing for Vaccine Conversations

The following scenario between a provider and a parent illustrates five skills for using motivational interviewing in vaccine discussions: open-ended questions, affirmation, reflection, autonomy support, and asking permission to share.

After introducing the human papillomavirus (HPV) vaccine in a presumptive manner, the provider meets resistance:

- **Provider:** So you seem to have concerns about the HPV vaccine. Well, that's perfectly understandable—I've had a number of questions about this one. Would you mind sharing what your particular concerns are?
- **Parent:** Well, I've heard that it's a vaccine to prevent a disease that's transmitted by having sex, and she is a long way from having sex.
- **Provider:** So I can hear that you're concerned that she's too young for the HPV vaccine because HPV is transmitted by sexual activity. Well, I completely get that—she is only 11 after all. I've thought a lot about this. Is it okay if I go over how I've come to think about this vaccine?
- **Parent:** Sure...
- **Provider:** I used to think of this vaccine as something to prevent a sexually transmitted disease, but realized it's really about preventing cancer. Almost everyone gets this virus, so I think it's important for everyone. If she were my daughter, I would not hesitate to recommend this vaccine for her, and most of my patients now are getting the vaccine. Having said that, this is a decision only you can make. What do you think?

SOURCE: O'Leary presentation, August 19, 2020.

DISCUSSION

Factors Affecting Herd Immunity

John asked whether herd immunity is helpful against outbreaks in settings where less than 10 percent of the population is unvaccinated. Mello explained that the prospects for achieving herd immunity vary across diseases as a function of two factors. First is the reproductive number of the disease (R_0)—that is, how many new cases emerge for each existing case within the population. The more infectious a disease is, the greater the vaccination coverage must be in order to achieve herd immunity. The second factor is the effectiveness of the vaccine. Increased effectiveness of a vaccine will be associated with a lower vaccination coverage required to achieve herd immunity. These two factors vary widely across various diseases, she noted. For example, in the case of measles, the R_0 is between 12 and 18, which is relatively high. Thus, a vaccination coverage rate of approximately 95 percent is required to achieve herd immunity against measles. Polio has an R_0 of 5–7, so between 80 and 85 percent vaccination coverage is sufficient for achieving herd immunity against polio. The R_0 of influenza is less than 2, so approximately 40 percent vaccination coverage against influenza is sufficient for herd immunity.¹³

Legal Options to Protect Children from Vaccine-Preventable Disease

John asked whether community members may seek a legal mandate to vaccinate a child with a vaccine exemption if that child is a known source of a vaccine-preventable disease. Reiss explained that it is not generally possible to take parents to court and ask for an order for that parent to have their child vaccinated. However, it may be possible in some cases—for example, when parents who share custody have a dispute about vaccinating their child—where the court may side with the parent who wants to vaccinate their child. Typically, only a guardian or the state can bring a case requesting for an order to vaccinate a child. She added that if a child is infected with a vaccine-preventable disease by another unvaccinated child, the parents may file a tort claim on the basis of parental negligence.

California Law and the Willingness of Physicians to Report Adverse Events

John expressed his concern that California vaccination policy may affect the willingness of physicians to accurately report adverse events encountered

¹³ For more information for the R_0 of these pathogens, see Fine (1993).

after vaccination. He asked how physicians should proceed should they observe a serious adverse reaction that has not been enumerated by the CDC Advisory Committee on Immunization Practices. Mello commented that she saw no clear connection between California's legislation and the willingness of physicians to report adverse effects after vaccination. She clarified that California legislation empowers the Department of Public Health to investigate physicians who write an exceedingly high number of vaccination exemptions, but it does not call for an investigation of physicians who report adverse effects after vaccination.

Shared Clinical Decision Making and Vaccination Discussions in Clinical Settings

John asked how physicians should approach shared clinical decision making in the context of vaccine discussions. O'Leary acknowledged that this issue has arisen in discussions around motivational interviewing techniques. Many health care providers are being trained using the shared clinical decision-making mode, which O'Leary applauded. However, this model is designed for preference-sensitive decisions, meaning that these decisions involve choosing between equally acceptable options. For instance, a patient may be eligible for either heart surgery or a stent to treat blocked arteries. There may be pros and cons to either option, so shared clinical decision making affords patients the opportunity to work through those options and their trade-offs. He noted that vaccination is a standard of care, so in that sense, vaccination discussions are not an appropriate context for using the shared clinical decision-making framework. Instead, techniques such as motivational interviewing are being implemented to help providers convey the facts related to vaccines and to help patients and parents understand those facts.

John asked whether physicians could engage in shared decision making with parents about the vaccination schedule if they are willing to vaccinate but express common concerns about the complexity and volume of childhood vaccinations. O'Leary remarked that this may be a question of semantics, because "shared decision making" refers to a specific set of practices. Providers working with families to vaccinate their children often use principles of shared decision making. However, the proper practices of shared decision making draw on a specific body of literature within the scientific and medical literature. He reiterated that these practices are intended to be used to make preference-sensitive decisions where there is no clear recommendation for physicians to make. In the case of vaccines, there are clear recommendations that are based on science. O'Leary remarked that when physicians and parents go outside of those recommendations, they are improvising and not properly engaging in a shared decision-making process. For instance, in shared decision making, elaborate decision aids may be used

by patients and providers to work through decisions based on the patient's beliefs. There are no such processes for determining alternative vaccination schedules, because there is a clear and consistent recommended vaccination schedule that is based on a large body of scientific studies and a consensus of experts. Thus, any attempt to improvise or engage in shared decision making about vaccine schedules is, by definition, departing from the clear recommendations about vaccination schedules, said O'Leary.

Wolynn added that children whose parents delay vaccinations may be at an increased risk of not receiving all recommended vaccines (Smith et al., 2010). He said that in his practice, he stays within the confines of the periodicity of the well-child visits, which occur between the ages of 2–4 months, 4–6 months, and 6–9 months. If the vaccinations are to be spaced out, which he allows to accommodate breastfeeding mothers, he uses that periodicity along with a robust callback system within his practice's electronic medical records system. O'Leary emphasized that there is no valid reason to depart from the recommended vaccination schedule to spread out a child's vaccinations. While there are many reasons people wish to do so, spreading out vaccinations puts children at greater risk of having a vaccine-preventable illness and likely increases the total pain experienced by children.

The Immunity Charm Project

John raised a series of pragmatic questions about the Immunity Charm: (1) whether bracelets might be passed on to children other than the child who has actually been vaccinated; (2) whether the Immunity Charm might introduce stigma into communities impacting those children who have not received a bracelet, especially if the bracelet became a requirement for school enrollment; (3) whether increasing popularity of the bracelet within a community might create a black market for the bracelets; and (4) whether the bracelet might pose a choking hazard for the infants wearing them. Carucci explained that the design of the bracelet precludes the possibility of children opening their own bracelet, which reduces the potential choking hazard. Furthermore, beaded bracelets similar to the Immunity Charm are already widely used in the communities in question. Mothers are generally already familiar with how to open and close the bracelets, and they would be free to put the bracelet on their child's ankle if they prefer. He reported that McCann's qualitative study indicates a good level of overall acceptance of these bracelets in communities, and they are confident that the forthcoming larger-scale quantitative study will reveal a similar level of acceptance. Regarding the potential for a black market, Carucci explained that the Immunity Charm will be launched with a strong communications strategy that includes information about the quality of the charms, the origin of the beads, and how each bead is associated with specific vaccines. Furthermore,

the beads will be given at the time of immunization by health care workers who themselves will reinforce these messages. McCann has considered engaging with women's groups in the communities where the Immunity Charm is used to have bracelets locally produced, thus adding a sense of community ownership to the intervention. Carucci added that many of the questions raised by John will be more fully addressed by the forthcoming quantitative study. In his opinion, the most critical question to be answered by that study is the percentage of parents who will choose to fully vaccinate their children as a result of the Immunity Charm intervention in their communities.

Designing Public Health Messages to Promote Vaccination

John asked about the approach of public service announcements that use shock value to promote public health awareness—such as advertisements about the risks of smoking and the importance of HPV vaccines—and whether this approach may be employed to promote forthcoming COVID-19 vaccines. Wolynn commented that these campaigns are designed to evoke an emotional response, which is known to be an effective approach. The designers of these campaigns try to avoid fearmongering, but they do intend to elicit an emotional response. Carucci added that the kinds of messages used in public service announcements should be, in part, determined by the context and health concern being addressed. For instance, polio vaccination rates are relatively low in Pakistan, but polio is rare in most Pakistani communities due to effective vaccination strategies in the past. Polio is primarily a concern in certain pockets of communities where the previous vaccination campaigns have not been effective. An advertising campaign aimed at increasing concern about polio would be unlikely to drive an increase in polio vaccinations in this setting, he added.

Advertising campaigns should account for the barriers to uptake, he suggested. In the case of vaccination against polio in Pakistan, the barriers had to do with mistrust of vaccinators rather than a lack of concern for the risk of polio. Communication strategies should be aligned with existing barriers, rather than developing strategies based on assumptions about the fear of a particular disease. For instance, he suggested that most cases of COVID-19 will result in a rather mild illness, so a campaign promoting COVID-19 vaccines on the basis of fear and the need for individuals to protect themselves from illness is unlikely to be effective. Reiss added that each public health campaign is narrowly targeted on the public health concern it addresses. For instance, HPV vaccination campaigns are aimed at increasing HPV vaccination to prevent cancer. While it is expected that new campaigns learn from the experience of existing and past campaigns, lessons learned may not be generally applicable across campaigns for all public health issues.

Carucci said that if a private-sector company were to launch a new vaccine product, it would create a market-shaping campaign in advance of the product's release. Such a campaign would be global but tailored to be context-specific in each region, addressing local fears and concerns. He expressed his concern about releasing new vaccines first, then trying to address fears and concerns later, because it is critical for vaccine advocates to preemptively shape the market and public perceptions to ensure good vaccine uptake. Wolynn pointed out that anti-vaccine sentiments vary widely across cultures and may be driven by religious objections, political conspiracies, or other culturally specific issues in addition to health and safety concerns. Speaking from his own experience and his work with the International Pediatric Association, Wolynn said that he has encountered a wide range of diverse concerns about vaccination. For instance, members of the Somali American and Orthodox Jewish populations within the United States often have unique sets of concerns about vaccination.

Designing Campaigns for COVID-19 Vaccination

John asked whether any information was available about potential campaigns for forthcoming COVID-19 vaccinations. O'Leary said that CDC is considering these issues. However, until the safety profiles and other characteristics of forthcoming COVID-19 vaccines are known, the messaging to promote those vaccines cannot be fully developed. Regardless of the messaging around these vaccines, it will be crucial to engage with communities prior to the COVID-19 vaccine rollout in order to understand community concerns so that there is an open dialogue from the start of the COVID-19 immunization process. Wolynn added that because COVID-19 vaccines are being rapidly developed, there will be no information with which to preemptively inoculate the public against misinformation. Vaccination advocates will have to react quickly to address disinformation, which has already begun to be distributed in advance, once good information is available. Reiss said that long-standing vaccine advocates, such as Voices for Vaccines¹⁴ and Vaccinate Your Family,¹⁵ are preparing messaging to promote forthcoming COVID-19 vaccines. Wolynn said that leveraging trust and relationships is key to addressing vaccine hesitancy, and physicians and vaccine advocates must be armed with good information and use their trusting relationships appropriately. Carucci said that the sources of information should also be considered in designing campaigns, because there is a high degree of mistrust

¹⁴ More information about Voices for Vaccines is available at <https://www.voicesforvaccines.org> (accessed October 14, 2020).

¹⁵ More information about Vaccinate Your Family is available at <https://www.vaccinateyourfamily.org> (accessed October 14, 2020).

in government and science. Thus, it may be necessary to look beyond medical voices to provide information about vaccines.

Online Communication About Vaccination

John asked for specific advice about how vaccine advocates should communicate online about vaccines, noting that merely providing facts is not always effective. Wolynn said that Shots Heard Round the World has approximately 900 volunteer advocates. These volunteers need access to well-prepared and accurate information that is relevant to whatever vaccine-related issue that comes up, because they do not have the time to conduct their own research for each encounter. Furthermore, he added, health care providers are not necessarily required to spread beneficial information about vaccines. For instance, in the United States, community health workers and community health advocates are already embedded in communities and have trusting relationships with patients. Wolynn said that to get the right information to the right people, the information must be easily searchable and easy to cut and paste for use on social media platforms. He added that departments of health are generally more trusted at the community level, because the erosion in trust has most significantly affected larger health systems and government. He suggested finding ways to partner with departments of health and work to collaboratively share information both through social media and community-level campaigns; the latter may be especially valuable in areas and neighborhoods impacted by disparities in health resources.

Rationality of Decision Making

John pointed out the common sentiment in vaccination advocacy that human decision making is often irrational. However, this may be a misleading characterization, as decisions are often more rational when they are evaluated in the context of the various factors that influence individuals' decisions (e.g., personal priorities and risk/benefit considerations). He voiced the concern that characterizing individuals' decisions as "wrong," "irrational," or "misinformed" does not account for the numerous factors that influence decision making, and he asked how a more compassionate response to vaccine hesitancy might be encouraged. Wolynn commented that communication strategies, such as motivational interviewing and AIMS, teach practitioners to engage and communicate through active listening. O'Leary added that one purpose of conversational strategies, such as motivational interviewing, is to foster empathetic discourse so physicians can understand patients' perspectives, meet them where they are, and convey information in a way that the patient may be receptive to—all while avoiding argument.

It is easy to fall into a back-and-forth conversation, which can then escalate into an argument, he said, and such conversations are not productive for either party. He clarified that the characterization of human decision making as “not always rational” is not intended as a sign of disrespect toward individuals’ beliefs or capacity for rationality. Rather, this characterization acknowledges the role of emotions, beliefs, and factors other than rationality or science in people’s decision making. Furthermore, individuals often need to “digest” these various factors throughout the decision-making process. In the case of child vaccination, parents face complex decisions that are influenced by numerous factors beyond the facts. It is because decision making is shaped by numerous factors that merely presenting individuals with facts may not be sufficient to give them confidence in the right decision.

Status of Immunization Exemption Policies Across the United States

John asked about the status of immunization exemption policies among states that are considering restricting their exemptions. Mello explained that the measles outbreaks in 2014, 2015, and 2018 have raised concerns about vaccination exemption policies among state legislators. Maine and New York have made changes similar to those made in California, and numerous states have attempted but failed to pass similar legislation. She added that along with efforts to restrict exemptions there are efforts under way to expand exemption policies in some states. The latter efforts are being driven by the anti-vaccination lobby in response to the growing concerns among lawmakers about outbreaks of vaccine-preventable diseases, she said. While there have been more bills introduced aimed at expanding exemptions than at restricting exemptions, bills introduced that are aimed at restricting exemptions have been more successful to date.

Promoting Seasonal Influenza Vaccination

John described a common scenario where parents have kept their children up to date on their childhood vaccinations but steadfastly refused the influenza vaccination. He asked whether physicians should press this issue and potentially risk upsetting the family’s adherence to the non-influenza vaccination schedule. Wolynn said that physicians can be well equipped to discuss flu vaccines, acknowledging the truthfulness of the common sentiment that the influenza vaccine is not always effective. While the influenza vaccine’s effectiveness varies, even a relatively low percentage of protection against disease is better than no protection. He explained that physicians can discuss the potential value of vaccination to reduce the severity of infection and mortality even if the patient becomes infected with influenza. Patients can also leverage the power of narrative, he added. For instance, he often

shares the story of a mother whose 17-year-old son told her he felt ill and then died within 24 hours. This mother now works with Families Fighting Flu to spread awareness about these issues.¹⁶ Narratives such as these can be powerfully leveraged to promote vaccination.

¹⁶ More information about Families Fighting Flu is available at <https://www.familiesfightingflu.org> (accessed October 15, 2020).

6

A Systems Approach to Increasing Vaccine Confidence and Uptake: Opportunities for Community-Based Strategies

The second half of the workshop's third session focused on how community-based approaches and strategies can effectively and ethically be employed to reduce vaccine hesitancy and increase vaccine confidence. The session was moderated by Rafael Obregon, United Nations Children's Fund (UNICEF), who highlighted the importance of dealing with vaccine hesitancy and vaccine confidence as parts of a larger ecosystem that includes other systems and services. These issues are inseparable from how communities, parents, and individuals engage with providers, as well as context-specific levels of trust and confidence that are built in those relationships. Mohamed Jalloh, senior behavioral epidemiologist at the U.S. Centers for Disease Control and Prevention (CDC), presented on social mobilization as a strategy to increase vaccine acceptance and uptake. Catherine Jackson, director and World Health Organization (WHO) consultant at Valid Research Limited, described how the COM-B model was adapted and integrated within the Tailoring Immunization Programmes (TIP) approach to increase vaccination acceptance and uptake. Clarissa Hsu, assistant investigator at the Kaiser Permanente Washington Health Research Institute, presented on the Immunity Community, a community-engagement strategy to boost vaccine confidence. Louise Letley, nurse manager for Research, Immunisation Operations at Public Health England, provided an example of engaging with faith communities to increase vaccine acceptance and uptake in North London's Charedi Orthodox Jewish community. Patsy Stinchfield, senior director of infection prevention and control at Children's Minnesota, presented an example of engaging with immigrant communities to increase vaccine acceptance and uptake in the

Somali American community in Minnesota. Each speaker presented an example of *how* trust and confidence can be built under different contexts, the lessons learned, and the models used to address these challenging issues.

SOCIAL MOBILIZATION AS A STRATEGY TO INCREASE VACCINE ACCEPTANCE AND UPTAKE

*Presented by Mohamed F. Jalloh, U.S. Centers for Disease
Control-Tanzania*

Jalloh explored how social mobilization can be used as a strategy for increasing vaccination acceptance and uptake. He noted that experiences with these strategies from low- and middle-income country (LMIC) contexts have crosscutting implications and could potentially inform social mobilization strategies in the United States. Jalloh and colleagues published a commentary on lessons learned from social mobilization for immunization comparing experiences in different LMICs, including Bangladesh, India, and Sierra Leone, among others (Jalloh et al., 2020). The study examined social mobilization across a number of contexts: routine immunization, supplemental immunization activities, campaigns, new vaccine introductions (e.g., human papillomavirus), and outbreak response. Jalloh presented two examples of successful social mobilization campaigns drawn from this commentary to help contextualize issues related to social mobilization and to identify crosscutting lessons learned.

Functional Definitions of Social Mobilization

Jalloh noted that the term *mobilization* has its roots in the military concept of mass military mobilization, which involves well-coordinated and comprehensive activities that go through a chain of command, and he presented two functional definitions of social mobilization. UNICEF defines social mobilization as “a process that engages and motivates a wide range of partners and allies at national and local levels to raise awareness of and demand for a particular development objective through dialogue.”¹ He noted that the UNICEF definition—which is widely used—emphasizes that social mobilization is a process that involves engagement. In another functional definition, Rogers and colleagues describe social mobilization as “the effort to marshal many people to perform behaviors that impose a net cost on each individual who complies and provides negligible collective benefit unless performed by a large number of individuals” (Rogers

¹ More information about social mobilization is available at <https://www.unicef.org/policy-analysis/42347.html> (accessed November 5, 2020).

et al., 2018). Jalloh remarked that this definition highlights the need for collective effort to achieve a collective outcome; it also recognizes that social mobilization imposes a net cost on each individual, be it financial or social. He added that both definitions construe social mobilization as a means to an end, such as the increased uptake of vaccinations. In their commentary, Jalloh and colleagues developed a definition of social mobilization for immunization as “the collective effort by diverse stakeholders to ensure optimal vaccination uptake in a target population by generating and sustaining demand for vaccines using community-based participatory approaches” (Jalloh et al., 2020).

Universal Child Immunization Campaign in Sierra Leone (1985–1990)

Jalloh described the universal child immunization (UCI) campaign implemented in Sierra Leone (1985–1990) as an early example of successful social mobilization. The UCI campaign was launched with the aim of achieving universal vaccination coverage by 1990 for all children worldwide against six antigens: measles, tetanus, whooping cough, diphtheria, tuberculosis, and polio (Mandl, 1985). In 1985, Sierra Leone recognized it was lagging behind in achieving the immunization targets established under the UCI campaign. With only 6 percent of the country’s children vaccinated against the six antigens by 1985, Sierra Leone’s vaccination coverage lagged behind most nations worldwide, including most countries in Africa. In an attempt to improve vaccine coverage, Sierra Leone’s Ministry of Health (MOH) invested in interventions that primarily focused on supply-side components of vaccine service delivery—such as improving and enhancing the cold chain—but coverage did not improve.

By early 1987, Sierra Leone only achieved 10 percent vaccine coverage, said Jalloh. In response, the MOH and UNICEF conducted a survey of knowledge, attitudes, and practice. It revealed that many survey respondents had inadequate knowledge about vaccines and intended to refuse vaccination. For example, at the time, Sierra Leone did not even have an indigenous word for *vaccine*. Without a word for vaccine, respondents had difficulty in receiving information about vaccines in local languages. Additionally, respondents reported that they did not have information about where and when to access vaccinations. The survey also revealed that many respondents intended to refuse vaccination because of the perception that vaccines were incompatible with religious and traditional belief systems.²

² The Pew-Templeton Global Religious Futures Project estimates that in Sierra Leone, most of the population identifies as either Christian (20.4 percent) or Muslim (78.5 percent). See <https://www.state.gov/reports/2018-report-on-international-religious-freedom/sierra-leone> (accessed February 18, 2021).

In response to these survey findings, the government of Sierra Leone, with support from UNICEF and other partners, designed a robust nationwide social mobilization campaign that extended across the national, district, chiefdom, and community levels. Jalloh explained that a primary component of the campaign strategy—and a major factor in its success—was to engage religious leaders, given that many survey respondents believed that vaccination did not align with their religious beliefs.³ Rather than providing religious leaders with messages to disseminate, the government's strategy was to explain the challenges faced in the vaccination campaign and seek to partner with the religious leaders to develop solutions. To develop familiar and easily understood language to frame conversations about vaccination, the leaders found passages in their religious texts with messages that supported immunization to develop the messaging. Then they trained fellow imams and pastors at the national, district, and community levels. The religious leaders were well organized and widely distributed, noted Jalloh, which enabled them to use their platform and position as influential messengers to promote immunization through faith-based messaging across the entire country. The government also engaged the media, educators, and traditional institutions, as well as recruiting paramount chiefs⁴ as ambassadors for immunization. Within 3 years, Sierra Leone had achieved a dramatic improvement in vaccination coverage, from 10 percent in 1987 to 75 percent in 1990 (UNICEF, 1991).

Jalloh noted that contemporary governments face many of the same issues addressed in Sierra Leone three decades prior. He emphasized that even though these structures might be difficult to keep and maintain, once a country has made investments in social mobilization, those structures can be easily repurposed for purposes beyond immunization. For instance, during the Ebola outbreak in Sierra Leone (2014–2015), the government was able to quickly leverage the religious action groups from the UCI era to scale up widespread social mobilization nationwide.

Improving Vaccination Coverage Among Displaced Rohingyas in Bangladesh (2018)

Jalloh remarked that social mobilization has played a pivotal role in other immunization campaigns—such as the successful eradication of polio in Uttar Pradesh, India—but he focused on how social mobilization was used to improve vaccination coverage among Rohingya refugees who

³ Based on the majority religions, the MOH and UNICEF organized the country's religious leaders into two action groups: the Christian Action Group and the Islamic Action Group.

⁴ In a country such as Sierra Leone that is administered by chiefdoms, a *paramount chief* is the highest-ranking leader in a given region.

arrived in Bangladesh from Myanmar in 2018 (Coates et al., 2013; Jalloh et al., 2019). Even though vaccines were available, people living in the refugee camps were not accessing them for reasons that were not well understood. A rapid behavioral assessment was conducted to better understand why the uptake of vaccinations was low. Many of the Rohingyas reported believing that getting vaccinated would cause a scar that would be considered a tattoo, which is forbidden by Islam and would cause them to go to hell when they die. Data from the rapid assessment were used in real time to inform the next vaccination campaign. By engaging religious leaders, traditional healers, and women leaders in the Rohingya camp, they were able to increase vaccination coverage by 10 percent in the next campaign.

Recurring Challenges in Using Social Mobilization for Immunization

Social mobilization can give rise to many different challenges, noted Jalloh. One such challenge occurs when campaign representatives repeatedly engage communities on vaccine-related topics to the point of fatigue and to the exclusion of other issues related to the well-being of communities, such as social and economic interests that may be a priority for them. However, the majority of those challenges involve human resource constraints, inadequate funding, and weak monitoring and evaluation. For example, social mobilization efforts often have inadequate or nonexistent budgets within vaccination campaigns. As a result of underfunding and lack of foresight, many campaigns encounter problems that could have been solved by properly funding social mobilization at the campaign's inception. Instead, campaigns too frequently treat social mobilization as an afterthought and fund it on a one-off basis. Furthermore, many vaccination campaigns do not budget enough to adequately staff their social mobilization efforts. The effectiveness of social mobilization campaigns can also be undercut when monitoring and evaluation practices are weak, he added.

Lessons Learned from Social Mobilization Efforts in Vaccination Campaigns

Jalloh highlighted five main lessons learned from past experiences in using social mobilization in vaccination campaigns:

1. Avoid the “spare tire” problem.
2. Do not conflate social mobilization with message dissemination.
3. Get the right people.
4. Use behavioral science insights.
5. Use standards, improve quality, and demonstrate effect.

He explained that the “spare tire” problem arises when campaigns consider social mobilization as an afterthought or they only consider it when problems arise, which can render the mobilization efforts largely ineffective. Instead, social mobilization should be considered one of the four main (proverbial) tires, if not the steering wheel. Jalloh drew an analogy with the military to illustrate the “spare tire problem.” Military mobilization is not a spontaneous response to an emergent problem, but a planned response to an anticipated problem. Furthermore, military mobilizations succeed when there is buy-in at all levels, from the highest-ranking generals to the lowest-ranking soldiers, which is achieved by involving and engaging all parties. Immunization campaigns benefit from treating the campaign as a single, coherent social mobilization effort, he maintained.

Message dissemination is a component of—but not tantamount to—social mobilization, cautioned Jalloh. “It is not just about the messages, [but] about how those messages are delivered,” he said. The messenger is equally as important as the message, and how the message is delivered can be even more important. The messenger’s identity, roles, and relationships within the community determine whether people listen to and engage with the message being delivered, regardless of how clear and powerful that message is. Moreover, messages are best delivered by proactively engaging the right people throughout the process of designing, implementing, and monitoring a campaign. Therefore, immunization campaigns should avoid “talking at” the community. Instead, they should engage communities in the design, implementation, monitoring, and evaluation of the mobilization strategies. He noted that too often, campaigns only engage key individuals upon implementation.

Jalloh also highlighted the value of applying insights from behavioral science when designing social mobilization strategies. Such insights include (1) making the behavior observable, (2) normalizing the behavior, (3) aligning the behavior with how people would like to see themselves, and (4) using existing structures and networks in the community. Because social mobilization and community engagement can be somewhat nebulous concepts, he suggested that it will be important to apply standards to improve quality and demonstrate the effect of interventions that operationalize those concepts. He noted that UNICEF had recently published a document that highlights the minimum quality standards and indicators for community engagement,⁵ which can help shape the design and evaluation of high-quality social mobilization efforts. He suggested that such standards should be used to understand process-oriented issues related to social mobilization and to

⁵ UNICEF’s minimum quality standards and indicators for community engagement is available at <https://www.unicef.org/mena/reports/community-engagement-standards> (accessed October 22, 2020).

more deeply integrate quality improvement as a core component of social mobilization efforts. Jalloh concluded by emphasizing that social mobilization is not one size fits all—it must be tailored to specific contexts—and data should continue to be generated and used to inform the next generation of strategies.

ADAPTING COM-B FOR THE TAILORING IMMUNIZATION PROGRAMMES APPROACH TO INCREASE VACCINATION ACCEPTANCE AND UPTAKE

Presented by Catherine Jackson, Valid Research Limited

Jackson described how the COM-B model of behavior change was adapted for the WHO TIP approach to increase vaccination acceptance and uptake.^{6,7} She provided an overview of how both models can be tailored for vaccination behavior, and she described how the combined approach was used to inform the design of interventions to increase vaccination among internal migrant families in Kyrgyzstan.

The Tailoring Immunization Programmes Approach

The TIP approach is typically initiated to address below-target or declining vaccination coverage in specific unimmunized and underimmunized populations at the national level or within certain population groups or geographic areas. The approach was developed to guide health authorities through an evidence-based and people-centered approach that acknowledges the complexity of vaccination behavior and the diversity of populations. She emphasized that TIP is not a one-size-fits-all approach—it is a communications-based intervention that is designed to facilitate targeted and tailored solutions within a holistic program view.

COM-B Model of Behavior Change

Jackson explained that the COM-B model was developed as a part of the behavior-change wheel to help advance the science of behavior change (Michie et al., 2011). The model has extensive application across multiple

⁶ COM-B is the behavior theory model that informs the analysis and intervention design for the TIP approach. More information about the Tailoring Immunization Programmes approach is available at https://www.who.int/immunization/programmes_systems/Global_TIP_overview_July2018.pdf?ua=1 (accessed November 4, 2020).

⁷ The COM-B model of behavior change posits there are three factors—Capability, Opportunity, and Motivation—that together influence Behavior. This model is explained in detail in a following section.

health behaviors and was designed to support practitioners through practical applications, as well as designing and evaluating public health interventions and policies. According to the COM-B model, three factors must be in place for a health behavior to occur: capability, opportunity, and motivation. Capability includes physical and psychological capability, motivation includes automatic and reflective motivation, and opportunity includes social and physical contexts. Capability and motivation are associated with individuals, while opportunities are associated with the individual's physical and social context. All three factors exert influence on some of the other factors, she noted. For example, an individual's motivation can be influenced by their capabilities and the opportunities in their environment. All three factors combine to influence and produce a behavior and, conversely, an individual's behaviors can influence all three factors. For instance, a person's vaccination history is likely a good predictor of future vaccination behavior. Much research has been conducted using the COM-B model, including work done by Jackson to adopt COM-B for TIP.

Rationale for Using the COM-B Model

Jackson discussed the rationale for applying the COM-B model in the TIP approach. COM-B offers broad perspectives on individual and context determinants, which helps avoid blind spots. For example, vaccination program managers often attribute low uptake to well-educated middle-class parents who refuse to have their children vaccinated, particularly in the case of the measles, mumps, and rubella (MMR) vaccine. However, Jackson explained, using the COM-B model rather than merely relying on the assumptions of any single stakeholder ensures that all explanations for behaviors are considered. The COM-B model is applicable for evaluating the vaccination behaviors of various stakeholders, including parents and health workers. A growing body of global evidence on the determinants of vaccination behaviors has confirmed the relevance of the three factors identified by the COM-B model, she said. Unlike other models, COM-B accomplishes the following:

- Links research findings to interventions and effects,
- Provides clear steps to understanding the barriers and drivers to behavior,
- Designs interventions that target those barriers and drivers, and
- Links the monitoring and evaluation framework back to those barriers and drivers.

Jackson commented that the theoretical basis of the COM-B model has developed considerably since 2011, as new complex theoretical processes

have been added to the existing framework. These new theoretical processes include theoretical domains framework (Cane et al., 2012), mechanisms of action (Connell et al., 2016), and Behavior Change Technique (Steinmo et al., 2015). Because COM-B is simple and easy for people in the field to comprehend and use, Jackson and colleagues continue to use this approach in their work.

Adapting the COM-B Model for Vaccination Behavior

Jackson explained that the COM-B model has been adapted for vaccinations based on lessons learned through fieldwork conducted in several countries as well as the translation of research into interventions. To better suit the vaccination setting, the COM-B model has been adapted by (1) distinguishing between physical opportunity and social opportunity and (2) consolidating the subcategories of capability (physical, psychological) and motivation (automatic, reflective) factors (Habersaat and Jackson, 2020). This results in four factors (individual capability, individual motivation, context-specific physical opportunities, and social opportunities) that interplay to shape vaccination behavior (Habersaat and Jackson, 2020).

Jackson explained the rationale for this adaptation through the example of asking parents about vaccine safety. The original COM-B model would make a clear distinction between *thinking about* vaccine safety (reflective motivation) and *worrying about* vaccine safety (automatic motivation). In practice, however, it would be difficult for researchers to maintain such a distinction during interviews and subsequent data analysis. Moreover, such a distinction does not add value to the intervention design process, she added. Similarly, the original model's distinction between physical and psychological capacity adds little value when applied to health workers' capacities for administering vaccination, as health workers' physical ability to administer a vaccine is interlinked with their psychological knowledge about how to do so. She noted that data that are relevant to the factors and sub-factors of the original model are still being collected.

Using COM-B in the Tailoring Immunization Programmes Approach

Jackson described how the adapted COM-B model of vaccination behavior is embedded within the TIP approach. The TIP process involves five distinct steps: planning (pre-TIP), situation analysis (phase 1), research (phase 2), intervention design (phase 3), and implementation, monitoring, and evaluation (post-TIP). In the situation analysis phase, governments and researchers inform their decisions about population focus and population target groups by reviewing coverage and disease data and identifying existing relevant research and reports. If they find evidence for barriers and drivers

to vaccination behaviors in the existing data, they can begin to organize that information using the COM-B factors. In the research phase, governments and researchers explore the barriers and drivers to positive vaccination behaviors among the TIP project's target population. Interview topic guides and surveys are designed to explore the four factors; the analysis is then organized in terms of the four factors. In the intervention design phase, practitioners identify evidence and theory-informed interventions that relate to the four factors. Finally, a monitoring and evaluation framework is used to assess the effect of the interventions by measuring changes in the targeted factors, she said.

Intervention Design

Jackson explained how the COM-B model is used to help inform intervention design (Michie et al., 2011). During the intervention design phase, Jackson's team conducts a series of activities to translate research findings into interventions through workshops with key stakeholders. These activities help new practitioners of this method understand and appreciate the link between the four factors and appropriate interventions. Applying the COM-B model helps identify specific types of interventions that can be used to address each of the four (adapted) COM factors of capability, motivation, physical opportunity, and social opportunity.⁸ For instance, if interviews during the research phase reveal that parents are not reminded of their child's appointment and that there is no formal recall or reminder system in place, the practitioner would designate this as a barrier to the physical opportunity factor. The COM-B model identifies a list of potentially appropriate interventions, which in this case would include training, restriction, and environmental restructuring. In the above case, Jackson suggested that practitioners consider implementing a short message service reminder system and training the primary health care administrators to operate the system.

Using the Tailoring Immunization Programmes Approach in Kyrgyzstan

Jackson provided an overview of the geographic distribution of TIP use. To date, most use has occurred in Europe across a diversity of countries and target populations, covering health workers, caregivers, and parents.⁹ To

⁸ Types of interventions include information/education, persuasion, incentivization, coercion, training, restriction, environmental restructuring, and modeling.

⁹ The Tailoring Immunization Programmes approach has been used in the following countries and target populations: Armenia (medical experts), Australia (communities with lower coverage in several regions), Bulgaria (vulnerable and Roma populations), Estonia (alternative health views population), Federation of Bosnia and Herzegovina (health

illustrate how the approach is implemented in practice, she described the TIP project in Kyrgyzstan for a target population of internal migrant families, which was selected based on the situation analysis. These families tend to move from rural areas to the cities, where they often live in exurban settlements with poor housing and few amenities. A legislation review revealed an overlooked physical opportunity barrier for parents to have their children vaccinated. Although Kyrgyzstan has passed legislation that enshrined free universal primary health care, other legislation was passed to limit primary health care access to the citizen's registered location. The primary health care facility registration process is a challenge for many migrant families, she noted. Additional research was conducted to study parents and grandparents of vulnerable internal migrant children to learn more about related barriers. Parents reported difficulties attending facilities without registration and without a record of their child's vaccinations. Many parents reported that they could not access their paperwork, which was held at their original facility of registration. Parents also reported that their original facility could not transfer the paperwork. Many health workers reported that when vaccination records are missing, they fear "over-vaccination" and prefer not to vaccinate. Moreover, health workers had low knowledge regarding the internal migrants' constitutional right to vaccination. These are examples of physical opportunity barriers, capability barriers, and motivation barriers, she noted.

Multiple interventions were implemented following the completion of the TIP project in Kyrgyzstan. The first intervention involved collaboration with UNICEF, which was already implementing a TIP-informed social mobilization project with parents in some of the same settlements and communities. Although the TIP project was focused on interventions for health workers, UNICEF used the research findings to augment its work with parents and support its own interventions. A second set of interventions focused on environmental restructuring and training to address gaps around knowledge and capability. UNICEF advocated successfully for a change in legislation that would enable parents to bring their child for vaccination without any documentation and without being registered in an urban health facility. A new ministerial order was issued to clarify internal migrants' right to vaccination. The government supported this policy change by training health workers on the ministerial order and procedures for vaccination in cases with missing records. Workers also received updated information

workers and parents), Germany (health workers), Kyrgyzstan (urban migrants), Lithuania (pregnant women), Mauritania (health workers), Montenegro (health workers), Norway (childhood vaccination), Romania (parents and health workers), Serbia (health workers administering flu and routine vaccines), Sweden (Somali community, undocumented migrants, and the Anthroposophic community), and the United Kingdom (orthodox Jewish Charedi community).

about vaccination and undervaccination. Jackson added that the interventions were piloted and evaluated before being scaled up, and they are currently monitoring and evaluating vaccine coverage data to evaluate the effect of the interventions.

IMMUNITY COMMUNITY: A COMMUNITY ENGAGEMENT STRATEGY TO BOOST VACCINE CONFIDENCE

Presented by Clarissa Hsu, Kaiser Permanente Washington Health Research Institute

Hsu presented on the Immunity Community, a community engagement strategy to boost vaccine confidence. The Immunity Community was created through VAX Northwest, a public–private partnership focused on children’s health, and implemented by WithinReach, a Seattle-based nonprofit that connects parents in Washington State with needed health resources. When VAX Northwest and the Immunity Community were formed, there was escalating concern about the increasing rate of vaccine hesitancy in Washington. Between 1999 and 2011, kindergarten vaccination exemption rates increased in most Washington counties. In 1999, approximately half of the state’s counties had rates at or below 2.9 percent, with the highest rates at 5–5.9 percent. In contrast, between 2010 and 2011, the overwhelming majority of counties had rates above 3 percent, with eight counties exceeding 10 percent. Although there was some improvement in 2011, the state passed a new policy regarding kindergarten vaccination exemptions in 2012. This policy was similar to California’s changes to vaccination exemption policies, but not as robust, said Hsu. After the new policy was implemented, Washington’s overall exemption rate dropped to 4.6 percent¹⁰ and has remained at or near that level. Despite this improvement, the exemption rates in Washington State remain among the highest for school-aged children in the United States, she noted.

Development of Immunity Community

Immunity Community was created to address growing concern about the persistent problem of vaccine hesitancy, said Hsu. Early in this process, VAX Northwest conducted a literature review and held parent focus groups, which revealed two key insights. First, although the majority of parents vaccinate, they are a silent majority in that their voices are not often heard on

¹⁰ For more information on vaccine exemption rates in Washington State, see <https://www.doh.wa.gov/Portals/1/Documents/Pubs/348-246-SY2014-15-ImmunizationGraphs.pdf> (accessed December 18, 2020).

this issue. Second, parents who vaccinate their children are easily activated when people talk to them about herd immunity and the problem of vaccine hesitancy. Based on these findings, VAX Northwest developed a program to engage parents by working within existing organizations, such as schools and day care centers, to spread positive messages about vaccination. Immunity Community was then created with the help of a community advisory board and BC/DC Ideas, a marketing firm that specializes in social marketing campaigns for nonprofits.¹¹ The campaign developed a large number of materials, including a parent action guide and viral images for social media.¹² The parent action guide was used to train the parent advocates and included (1) information about vaccines, (2) guidance on difficult conversations using techniques such as AIMS and motivational interviewing,¹³ (3) ideas for community advocacy, and (4) updated information resources. Based on feedback from parents in focus groups after the first year, Immunity Community developed a campaign called the Real Parents Line. They created viral images, videos, and other materials—featuring actual parents and their quotes—that were designed for parent advocates to share on social media.

Evaluation of Immunity Community

The Immunity Community program was evaluated using a logic model approach that employs multiple data-collection activities to ensure robust data, said Hsu. Evaluation activities included (1) observation and document review, (2) activity and media tracking, (3) a parent survey, (4) interviews with key informants, and (5) focus groups with parents. As part of activity tracking, parent advocates tracked their monthly activity and returned monthly reports. In the parent survey, the campaign included a pre-post, cross-sectional parent survey to examine the parent's knowledge and attitudes. For the key informant interviews, the campaign conducted these interviews annually with parent advocates, representatives from schools and other organizations, and other relevant stakeholders. Focus groups with parents were conducted annually through organizations involved in the program. The evaluation demonstrated that the implementation of Immunity Community was successful, so the program was scaled up and expanded from 4 sites and 6 parent advocates in year 1 to 7 sites and 13 parent advocates in year 2, and then to 10 sites and 14 parent advocates in year 3. In years 2 and 3, the campaign also expanded in terms of trainings,

¹¹ More information about BC/DC Ideas is available at <https://www.bcdcideas.com/about> (accessed November 2, 2020).

¹² More information about Immunity Community is available at <https://immunitycommunitywa.org> (accessed November 2, 2020).

¹³ See Chapter 5 for more discussion of the AIMS (announce, inquire, mirror, and secure) method.

kickoff events for parent advocates, enhanced technical assistance, program materials, and web resources.

The evaluation of the campaign revealed that parent advocates had taken action to raise awareness by monitoring site vaccination rates, educating other parents, and generating conversations on social media. In monitoring vaccination rates, parent advocates played multiple roles. Although Washington State requires elementary schools, day care centers, and preschools to collect immunization information on the children who are participating in their program, the state has lacked resources to monitor and hold those organizations accountable. Immunity Community's parent advocates stepped in to help hold them accountable by providing tools for their organizations to collect data, reviewing their organization's records, and—on occasion—actively assisting in the collection of records. In educating parents, parent advocates organized question-and-answer sessions with local physicians, had one-on-one conversations with parents, stationed booths at science fairs, passed out merchandise associated with the campaign, and used Immunity Community's wheel of vaccination game to educate families. Some advocates were active on social media and worked to generate conversations around vaccines.¹⁴

Effect on Parental Knowledge and Attitudes About Vaccines

Hsu presented the results of the pre-post cross-sectional surveys that looked at parental knowledge and attitudes about vaccines before and after the Immunity Community program was implemented, which found that parental attitudes had become more supportive of vaccination after the intervention (Schoeppe et al., 2017). For instance, more parents said they agreed or strongly agreed with statements such as “I am concerned about other parents not vaccinating their child(ren)” (81.2 percent pre-intervention; 88.6 percent post-intervention). Fewer parents agreed or strongly agreed with statements such as “Vaccines are given to children when they are too young” (31.0 percent pre-intervention; 24.7 percent post-intervention) and “Individual people are responsible for choosing whether or not to vaccinate their child(ren)” (70.9 percent pre-intervention; 66.9 percent post-intervention). Parents also expressed more confidence that vaccinating their child was a good decision and less concern about the safety of vaccines, she added. Parental attitudes also changed with respect to vaccine hesitancy, said Hsu. Overall, they observed a decrease in vaccine hesitancy from the first cohort to the second cohort. The proportion of respondents who reported being “very hesitant” decreased

¹⁴ In one example, Hsu describes a parent advocate, Allison, who had 17 conversations with other parents, sent 11 emails about the Immunity Community program, took part in planning activities, and posted 11 social media posts in 1 year of participation.

slightly, from 3.8 percent to 3.1 percent. A larger decrease in hesitancy was observed among those who were “somewhat hesitant,” which dropped from 18.8 percent to 10.9 percent. This was expected because that group tends to be more easily influenced, she noted. Overall, there was a decrease of 38 percent in the proportion of respondents who reported being “very” or “somewhat” hesitant.

Impact on Policy

Immunity Community was able to effect organizational-level policy changes, primarily related to the collection of immunization information, said Hsu. In one notable policy change, WithinReach and two of the parent advocates worked with the organization overseeing all of the state’s cooperative preschools to adopt changes to their risk management manual, including new information about immunization and reports of immunization. They also established guidelines for collecting immunization data—requiring co-ops to appoint one to two people to be responsible for collecting immunization data—and provided guidance about how to address a disease outbreak. This policy change alone has the potential to impact 10,000 families in Washington State each year, she noted. Immunity Community also received local and national media coverage, which was another goal of the campaign (*The Bellingham Herald*, 2012; Rochman, 2013).

Lessons Learned from Immunity Community

Hsu highlighted three factors that contributed to Immunity Community’s success. First, schools provided leadership and support at the organizational level. There were some schools where teachers were resistant to Immunity Community’s messages, which posed challenges for the parent advocates. Second, reports from parent advocates demonstrated the importance of strong technical assistance and support from the campaign. Immunity Community’s program staff was responsive to parent advocates, providing them with resources when they had questions or concerns. Third, a culture of active parent engagement contributed to the success of Immunity Community. For example, parents helped to spread information by using existing virtual spaces, such as online forums, and physical spaces at the school where parents tend to encounter one another. Where there was no space for advocates to have conversations, leave materials, or engage other parents, the work was more challenging. Hsu discussed the challenges they faced around recruitment, implementation, and the issues of replication and sustainability. Recruitment, which accounted for an unexpectedly large proportion of total time spent during the Immunity Community project, is a challenge because it is so time intensive. It involves building trust at the community level and

with schools, day care centers, health departments, school districts, and other organizations; then, individual parents need to be recruited. Replication and sustainability were challenging due to resource constraints. She noted that when Immunity Community attempted to implement low-resource Immunity Community models, they were unable to get past the recruitment phase.

ENGAGING WITH FAITH COMMUNITIES TO INCREASE VACCINE ACCEPTANCE AND UPTAKE IN A CHAREDI ORTHODOX JEWISH COMMUNITY

Presented by Louise Letley, Public Health England

Louise Letley, nurse manager for research and immunization operations, Public Health England (PHE), outlined the TIP project carried out with the Charedi community in North London in 2015–2016 after outbreaks of vaccine-preventable disease originated in the community and spread to other countries. The TIP project in London, one of the first such projects, was conducted to determine effective methods of increasing vaccination uptake. Guidance to the TIP approach has since been updated, improved, and further streamlined.

The Charedi Community in North London

The North London borough of Hackney is home to the largest Charedi community in Europe, said Letley. This community of strictly observant Jews was already established in London in the 1920s, but the population grew significantly during World War II as new arrivals fled the Holocaust. Membership within the community was not systematically recorded in medical records, creating a challenge for the TIP project in terms of estimating population size. At the time of the TIP survey, the community had an estimated population of 25,000–30,000. The Charedi community in Hackney had suffered recurrent outbreaks of vaccine-preventable disease (e.g., measles outbreaks in 2007 and 2013), which indicated suboptimal immunization uptake. Furthermore, the Charedi community suffered a higher burden of disease during those outbreaks than other parts of the borough. Close links with Charedi communities in other parts of the world led to the export of measles from the United Kingdom to other countries, including Israel and Belgium. The perception among health professionals was that religious or cultural objections contributed to lower immunization uptake, she added.

TIP Process in the London Charedi Community

Letley described how the TIP process was conducted to address vaccination uptake among the Charedi community in London, with community

engagement and involvement emphasized at every step of the process (Letley et al., 2018). The first step was to hold an initial stakeholder meeting and determine the TIP focus. This meeting included local commissioners and immunization service providers, public health professionals, representatives from the PHE National Immunisation Team, and experts from WHO. The Charedi community was selected as the focus of an effort to identify immunization barriers and enablers. The next step of the TIP process was to map current immunization services by examining what was already taking place in the community. Mapping revealed that some small projects designed to deliver services in a flexible way had been conducted, but these tended to be short term and had not been evaluated effectively. Next, the project analyzed available surveillance and outbreak data.

The second stakeholder meeting actively engaged members of the Charedi community, including the senior rabbi for health,¹⁵ a Charedi nurse, staff from children's centers, and representatives from a Charedi support organization. Local commissioners and immunization service providers also continued to participate. Much of that meeting focused on an analysis of the strengths, weaknesses, opportunities, and threats of the current immunization policy, which informed a survey developed for parents. Community members contributed to the design, translated it into Hebrew and Yiddish, and checked it for cultural awareness. The survey was then distributed to parents through children's centers and general medical practices. After collecting survey results, in-depth interviews were conducted with parents and key informants to get additional information regarding some of the results. Once that process was complete, the stakeholders from the second meeting reconvened to present the results and prioritize findings to inform the recommendations made to commissioners, service providers, and the community.

Analysis of Findings from the TIP Process

Letley described the findings that emerged from the TIP process in the Charedi community. In addition to confirmation that the uptake of immunizations was lower within the Charedi community, data analysis showed that recurring vaccine-preventable diseases were placing a burden on the community, particularly in children under 4 years of age who would be protected by the routine childhood vaccination schedule. Charedi community

¹⁵ Letley highlighted the efforts of a participant of the TIP stakeholder group, the senior rabbi for health, Rabbi Avrohom Pinter, who died from COVID-19 in April 2020. Rabbi Pinter was pro-immunization from the start and became even more committed and vocal in his views through his work with TIP. She shared Rabbi Pinter's quote from a 2017 article in the *Jewish Chronicle* (Kollrin, 2017): "People don't take immunization seriously because they've seen those illnesses and think 'It isn't that terrible.' They don't realise that it could kill somebody else. We have a responsibility to others as well as to ourselves."

members tend to have more children than average, she noted. The analysis revealed that the proportion of children under 4 years of age in the Charedi community was larger than the proportion in the general national population. Data from general medical practices serving the Charedi community indicated that children under 4 years of age composed 10–17 percent of the registered community, compared to 6 percent nationwide. Thus, the Charedi community was weighted toward the younger age group, but did not have additional resources to support this population composition. A potential barrier identified was that general practice services were strained in providing immunization services to the high number of children in the community. Furthermore, parents of large families have many responsibilities and may not always prioritize the effort required to take their children to the clinic to be immunized, she added.

Although the survey was available to Charedi parents, all of the respondents were mothers, who tend to make most of decisions around health care in the Charedi community. Surprisingly, the survey did not highlight any barriers stemming from religious or cultural beliefs, noted Letley. Rather, issues related to access, wait times, and facility child-friendliness were prominent. For example, parents mentioned wanting reduced wait times and facilities featuring space to park strollers and a room for breastfeeding. Children's centers were a popular preference for additional immunization venues. Additionally, community-specific initiatives such as Sunday immunization clinics and Charedi nurse immunization providers were popular.

Data analysis indicated unmet immunization information needs within the community, said Letley. During the in-depth interviews, participants were asked what might improve vaccination uptake or services. Responses suggested providing more information or information that was less biased through up-to-date leaflets, magnets, and wall calendars; email reminders when vaccinations are due; informal information sessions at children's centers; posted information about the immunization helpline; receiving information from someone within the culture; and religious guidance. To improve access, respondents suggested providing walk-in clinics or clinics where it is easy to book appointments; nearby clinics or home visits; longer clinic operating hours; shorter wait times; comfortable and pleasant surroundings with space for strollers, such as children's centers; and school immunizations.

Letley highlighted several clear messages that emerged through the TIP process. First, no evidence of any cultural or religious objection to immunization was found. In fact, Charedi community members' views on immunization were broadly similar to the wider population, Letley said. Resolving service access issues was found to be a priority in improving uptake. Furthermore, improved recording of community membership in health records would aid in monitoring uptake and targeting tailored interventions. Collaborating with community members, including charities and community

and religious leaders, was found to be invaluable. Lastly, community-specific interventions should be evaluated for effectiveness and cost-effectiveness.

Measures Implemented After the TIP Process

Letley remarked that the TIP project among the Charedi community generated many recommended measures for commissioners, service providers, and the community to increase vaccination uptake, several of which have since been implemented. For example, medical practices agreed to send families proactive reminders by text and follow-up phone call. A digital medical record called EMIS Web is used to track patient health care.¹⁶ Children are flagged in this system, which enables providers to remind parents of vaccinations that are due for any of their children, regardless of which child is scheduled for the appointment. If a child is attending a sibling's appointment, all possible vaccines falling within the UK schedule can be provided. For children not in attendance, reminders and alternative appointments are offered. Other measures include medical practices sending monthly data reports on vaccination activity to NHS England. The immunization providers in the borough of Hackney had a representative on the Hackney Immunisation Group, affording the opportunity to meet with public health professionals and commissioners. The practice payment process was altered to recognize special circumstances, which gave them more resources. Lastly, local authority and immunization providers explored options for community venues for immunizations, such as children's centers and other locations that might be more accessible to parents than general medical practices.

ENGAGING WITH IMMIGRANT COMMUNITIES TO INCREASE VACCINE ACCEPTANCE AND UPTAKE IN A SOMALI AMERICAN COMMUNITY

Presented by Patsy Stinchfield, Children's Minnesota

Stinchfield described efforts to engage with the immigrant Somali American population in Minnesota to increase vaccine acceptance and uptake after anti-vaccination messaging affected the MMR coverage rate in that community and outbreaks of measles occurred.

Somali American Population in Minnesota

Drawing from Ahmed Yusuf's book, *Somalis in Minnesota*, Stinchfield described the immigration trends of Somali refugees in the state (Yusuf, 2012).

¹⁶ More information about EMIS is available at <https://www.emishealth.com/products/emis-web> (accessed November 6, 2020).

Minnesota has historically welcomed refugees and immigrants, its original settlers being German, Irish, and Swedish immigrants. In more recent decades, immigration patterns have shifted to an influx of refugees from the Hmong community in Laos, Liberia, and Somalia. Somali refugees began settling in Minnesota in 1993 and continued to increase because of the availability of jobs, the level of community acceptance, the quality of life, and a strong, welcoming social service system. Stinchfield noted that the Somali American community is an oral society that relies on word of mouth; thus, word spread from community members and religious leaders to Somali refugee camps that Minnesota was a welcoming state. By 2017, Minnesota had the largest Somali American community in the United States, comprising more than 52,000 people.¹⁷ In 2006, the apex thus far of Somali immigration, the state welcomed more than 3,600 Somali immigrants, compared to less than 50 in 2018. Stinchfield noted that the Somali American population is now well-integrated into the community at large, and members of the community have held local and national political offices.

Declining Measles Vaccination Rates and Subsequent Outbreaks

Stinchfield emphasized that historically, Somali immigrant vaccination rates matched those of the general population. For example, in 2004 in Minneapolis-Hennepin County, 92 percent of Somali American 2-year-olds were immunized compared to 88 percent of all county residents. Although these rates have remained steady for the general population, there was a shift in 2007–2008 in the Somali American community. The idea of the MMR vaccine causing autism began to infiltrate the community, and then a local anti-vaccine group began actively promoting that message to Somali Americans. In 2010 and 2011, Andrew Wakefield—who published the now debunked, small study that originally claimed a connection between MMR vaccines and autism—was invited to Minneapolis by the anti-vaccine group (Bhatt, 1998). Rather than inviting Wakefield to meet with the entire community, the group hosted him at a closed-door session with local imams. This resulted in mosques spreading the message that parents should not give their children the MMR vaccine, said Stinchfield. By 2014, the MMR coverage rate in the Somali American population in Hennepin County had dropped to 42 percent.¹⁸ Work is still ongoing to close the vaccination gap between Somali American and non-Somali American children in Minnesota, but the

¹⁷ More information about 2017 American Community Survey estimates is available at <https://www.census.gov/programs-surveys/acs/news/data-releases/2017/release.html> (accessed November 5, 2020).

¹⁸ More information about measles vaccination in Minnesota is available at <https://www.health.state.mn.us/diseases/reportable/dcn/sum17/measles.html> (accessed November 5, 2020).

efforts are currently hampered by the impact of the COVID-19 pandemic on immunization rates.

Children's Minnesota foresaw the possibility of an immunization rate drop and worked to avert such a scenario in the early 2000s. In 2002, the organization hired a Somali American film crew to make a video with Somali American providers. Children's Minnesota also had clinical leaders reach out to Somali American families in their own language. Yet, the efforts of Children's Minnesota and the public health department were not successful in warding off an outbreak. Stinchfield said she talked with many Somali American parents after the outbreak, asking them for their thoughts on what led to the situation. She quoted a mother who did not know why she was not supposed to vaccinate her child, and she later regretted it when her child was admitted with measles in 2017:

All I knew [in the refugee camp] was that when I came to America, don't take "the triple shot." I didn't know why, but now I have evidence of how dangerous it is not to protect your children.

In 2011, a study investigated whether Somali American parents were more likely than non-Somali American parents to refuse childhood vaccinations—particularly MMR vaccines—and to determine what factors influenced the decision not to vaccinate (Wolff and Madlon-Kay, 2014). Somali American parents were significantly more likely (35 percent) to believe that autism was caused by the MMR vaccine compared to non-Somali American parents (8 percent). Correspondingly, Somali American parents were more likely to refuse the MMR vaccine than non-Somali American parents. The study suggests that beliefs that the MMR vaccine causes autism contributed to an immunization gap between Somali American and non-Somali American children, noted Stinchfield.

Measles Outbreak in the Somali Population

By April 2017, MMR vaccine rates had dropped dangerously low among the Somali American community in Minnesota, leading to an outbreak of measles. Stinchfield said that young children—mostly preschool-aged Somali American children—began presenting at emergency rooms with fever, rash, cough, conjunctivitis, coryza (runny nose), and had the appearance of a person with a histamine reaction. Stinchfield noted that the rash can be difficult to see on darker skin tones, so providers need to look carefully and palpate for it.¹⁹ A total of 75 cases of measles were reported in the 2017 Minnesota

¹⁹ Stinchfield stated that with the COVID-19 pandemic affecting vaccine rates, medical professionals should keep measles in the forefront of their minds when examining children.

outbreak, 66 of which were in Hennepin County.²⁰ The vast majority of infected people (71) were children, 61 of whom were Somali American. Of the 75 cases, only 3 individuals were fully vaccinated for MMR and 68 were confirmed to be unvaccinated. Minnesota Children's hospital treated 53 patients with measles, with a median age of 3 years (range: 10 months–14 years). Twenty-one of these children had to be hospitalized, with length of stay ranging from 2 to 17 days and averaging 4 days. One child had to be re-hospitalized for pneumonia. Fortunately, no lives were lost.

In an effort to publicize the outbreak, Stinchfield asked a health reporter to document the outbreak from the individual families' perspective. The story received national and worldwide media coverage (Mele, 2017; Sun, 2017). During the same period, England and Sweden were experiencing similar outbreaks in their own Somali refugee communities (Tomlinson and Redwood, 2013). As in Minnesota, the health beliefs among community members were influenced by fear and mistrust, and concerns about autism were linked to decreases in MMR coverage.

Outbreak Response and Interventions

Stinchfield highlighted the value of building trust and leveraging systems communication in addressing a measles outbreak. For example, she suggested partnering with the media and ensuring that both the message and the messenger are carefully considered. Local-level communication should be tailored to social and cultural sensitivities, with information delivered in the community's language by a trusted messenger or community leader. Location of messaging is another consideration; it is important to determine where the community prefers to receive information, such as a mosque or another meeting space where participants are open to learning. Opportunities for one-to-one communication include the hospital or clinic where a child is being treated for measles.

To respond to the Minnesota outbreak, Stinchfield was part of a team that was formed to go from mosque to mosque to talk to imams. At these meetings, Stinchfield spoke about MMR, the American Academy of Pediatrics chapter president talked about the danger of measles, and another pediatrician spoke about autism. They separated those topics and discussed them with these trusted leaders in the community. In addition, Children's Minnesota conducted a series of interventions to connect with the Somali American community. The organization developed a Somali American employee resource group that continues to thrive today, said Stinchfield.

²⁰ More information about the 2017 measles outbreak in Minnesota is available at <https://www.health.state.mn.us/diseases/reportable/dcn/sum17/measles.html> (accessed November 5, 2020).

Furthermore, they sought feedback from Somali American clinicians from multiple institutions about how to improve their response efforts. They have also worked to build and foster trust with community imams and hosted public Ramadan Eid dinners to engage with the community. Informational materials have been translated to make them accessible to more people and Children's Minnesota is working to build a hospital staff and leadership that reflect the families the organization serves. In terms of public health interventions, the state health department conducted outreach via Somali American imams and Somali American health care providers, held multiple Somali American community meetings with health leaders and legislators, and ran culturally appropriate ads in Somali American radio and television outlets. Additionally, they ran newspaper ads and were interviewed for articles.

Evaluating the Effect of the Interventions

To evaluate the effect of the interventions to increase vaccination acceptance and uptake in the Somali American community in Minnesota, the state department of health conducted a survey of 300 parents whose children were previously unvaccinated, but received MMR immunization during the measles outbreak.²¹ They were asked what made them change their minds and how the vaccination affected their children. The vast majority of the respondents (95 percent) cited fear of measles as the motivation for vaccinating their children. About 80 percent reported having no concerns about how the vaccination affected their children and, for those who reported side effects, most were mild (e.g., fever, mild rash, pain at injection site, crying after the vaccine) and not long lasting. The majority of respondents said they trusted their health care providers as a source of information regarding vaccines.

Lessons Learned and Ways Forward

Stinchfield described lessons learned through this process of engaging the Somali American community around vaccination. For example, fear and mistrust are major obstacles to immunization coverage. Tapping into the Somali American oral communication method was a valuable strategy, as was using Somali-speaking health care professionals to engage with the community. Imams are leaders in their communities, so gaining their trust by visiting them, listening, and sharing can create powerful connections. Additionally, working with public health Somali American outreach workers can be an effective partnership. Communication modes should be used at all

²¹ More information about the Minnesota Department of Health's "Reporting Back to Health Care Providers: MMR Survey" is available at <https://www.health.state.mn.us/people/immunize/mmrsurv> (accessed November 5, 2020).

levels, from systemic to local/social to individual. Stinchfield remarked that “outbreaks change minds.” The mother of a child who was on a ventilator for 15 days during the 2011 outbreak said she did not know that a child could get so sick from measles. She asked Stinchfield to share a picture of her child in the hospital—connected to the ventilator and other equipment—so parents could learn the danger measles can pose to their children. The mother said, “Please let them know that we must care for them.”

Moving forward, Stinchfield suggested that measles be kept at the forefront of health professionals’ minds in order to intervene early, as well as increasing the use of vitamin A in the management of measles care in the United States. Children’s Minnesota has conducted studies indicating that improving vitamin A status can reduce the risk of serious complications (Stinchfield and Orenstein, 2020). She also noted that as the COVID-19 pandemic is decreasing vaccine rates worldwide, creativity will be needed to safely immunize children and maintain MMR vaccine rates. Otherwise, measles outbreaks could compound outbreaks of both COVID-19 and influenza once international travel resumes.

DISCUSSION

Obregon opened the discussion by highlighting the value of culturally centered interventions tailored to specific contexts and settings to address similar issues across different groups. He added that COVID-19 is posing challenges to other vaccination efforts.

Ensuring Immunization Card Availability and Use

Noting that surveys show large discrepancies between parents’ vaccination recall and card validation, Obregon said that this is largely due to parents not having vaccination records for their own children on hand. Vaccination cards for parents and clients are not sustainably available in many settings, especially those with weak health systems or other challenges. Obregon asked Jalloh how professionals can work collectively to ensure that vaccination cards are available and used. He added that this issue poses particular challenges to migrant communities, such as those moving from Venezuela to other countries in Latin America.

Jalloh responded that this is a complicated issue that warrants both low-tech and higher-tech but simple solutions that can be implemented as appropriate in different contexts. He said that in Bangladesh, the Rohingya population faced issues similar to those facing Latin American migrant communities. Because it was not possible to ascertain the level of immunization in the Rohingya community, a serosurvey was conducted to estimate the baseline immunization coverage of Rohingya refugees coming into Bangladesh. Jalloh

noted that serosurveys are not a sustainable method of tracking immunization coverage rates, so technology-based solutions should be explored. Innovation is already taking place in this area, such as the capability to insert copies of the vaccination card into people's phones. However, phones can be lost or damaged just as vaccination cards can. Electronic dual-purpose bracelets are a simple and low-tech solution being tested in Nigeria; they can retain the vaccination record and also provide reminders by lighting up when immunizations are due. In addition to exploring such innovations, Jalloh suggested the need for ways to improve the durability of home-based, paper-based cards because once cards become damaged, people are more likely to lose them.

Maintaining Engagement with Religious Leaders

Obregon asked how religious and faith leaders can be engaged in a sustainable way to maintain their ongoing alliance in addressing vaccine resistance and boosting confidence. Noting the positive experience during the TIP project in the Charedi community, Letley remarked that the rabbi who led health efforts was very engaged in the project from beginning to end. However, this rabbi made it clear that having one religious leader who is engaged does not necessarily mean the synagogue will indefinitely maintain the same level of engagement. Rather, it warrants a continuous process of engagement and reengagement over time, which is a time-consuming process that adds a degree of difficulty to ensuring sustainability. Another potential barrier to engagement is the potential for "one-offism"—that is, focusing exclusively on vaccination in communities that face many other issues of concern. Letley said that attaining and sustaining community engagement can be challenging, but it is helpful to engage community leaders from the outset and ensure that they remain involved at all stages. For instance, Charedi community members provided cultural awareness training to health care professionals to educate them about community beliefs, practices, and religious holidays. This cultural awareness enabled the health care providers to increase cultural sensitivity and avoid scheduling appointments on days of religious services or holidays.

Stinchfield said that in working with the Somali American population in Minnesota, her team came to appreciate that imams are not a homogenous group but individuals with diverse opinions and thoughts. When the measles outbreak began and providers began to investigate why half of Somali American parents were vaccinating their children and half were not, the opinions of imams were found to be highly influential. Families whose imams promoted vaccination tended to feel it was important to vaccinate. She added that personal experiences also contribute to vaccination attitudes, because some parents had seen measles in Somalia before coming to the United States and recognized its consequences. Stinchfield surmised that when Andrew

Wakefield was invited to speak with the imams in the Somali American community, their opinions about vaccinations were likely mixed before hearing him. However, Wakefield's charismatic message was effective in convincing many of them to discourage vaccination. Some of the imams told her that it was the first time a doctor had ever spoken with them. Regardless of whether this was strictly accurate, she acknowledged that many imams likely felt heard for the first time, because Wakefield made them feel special and was billed as a famous person—despite the fact that he was no longer a physician and his claims were not truthful. This demonstrates the importance of having trusted providers within communities to share accurate information, she noted. In addition to working with families individually to build trust and develop one-on-one relationships, broader efforts should focus on engaging the entire community, including both patients and providers, within a larger system of communication. Stinchfield noted that when they began investigating the reasons why measles outbreaks were occurring among Somali heritage communities across the world, they discovered that there is an international weekly phone call for imams in which a variety of topics are discussed. False information about MMR causing autism was being shared and quickly disseminated through this platform to Somali heritage communities worldwide. She suggested that similar widespread communication methods could be used to dispel myths and provide accurate information to help increase vaccination coverage.

Impact of COVID-19 on Vaccination Efforts

Obregon asked whether the COVID-19 pandemic is shaping conversations around vaccines for other infections. Jackson noted the effect it has had on childhood vaccination programs. For example, in Kyrgyzstan, the childhood vaccination program was suspended for 3 months. Bosnia and Herzegovina have had ongoing challenges with low vaccination coverage rates that improved somewhat after a TIP project was conducted there, but rates have plummeted again during the COVID-19 pandemic, she added. Hsu said that Washington State has had a decline in childhood vaccination rates during the pandemic. The overall rates are now recovering, but there is concern that the coverage rates for the large Somali American community in the state will not recover at the same rate. Hsu and colleagues are interested in conducting work to understand community-level responses to the COVID-19 pandemic and vaccination campaign. However, it is challenging to have conversations with specific communities without knowing the shape of the eventual COVID-19 vaccine (e.g., side effects, recovery time). She suggested the possibility of adapting a program like Immunity Community to respond to the concerns of specific communities regarding a COVID-19 vaccine in particular or childhood vaccines more broadly.

COVID-19 Vaccine Outreach

Obregon asked about communication strategies for working with closed immigrant communities in the United States on contact tracing or COVID-19 vaccine hesitancy. Stinchfield suggested having community members who speak the native language be the primary channels of engagement and communication. Ideally, those individuals would be employed by public health—or at least partner with public health—to build trust for these efforts among the community.

Obregon asked how lessons learned from previous experiences can inform efforts to introduce the COVID-19 vaccine. Jalloh responded that work should begin to anticipate issues, start engaging communities, and use existing structures. The “spare tire” approach—that is, only initiating community engagement once a problem arises—can be avoided by initiating planning and engagement efforts as soon as possible. Engagement increases as a function of the extent to which social mobilization structures are engrained and sustained within a community and used to address crosscutting issues, he noted. When health providers only come to a community to discuss specific public health objectives, a top-down method is being used.

The organic, bottom-up approach to engagement that extends beyond a specific epidemic or public health emergency is more robust than a top-down, narrowly focused approach, he added. His work in West Africa highlighted the value of building on existing structures, continuing dialogue, maintaining engagement, and bringing communities into conversations. People often have similar objectives that they approach from diverse perspectives founded on different values, which need to be understood so communication strategies and other efforts can be aligned with those values, he added.

Letley said that in England, they are preparing for the COVID-19 vaccine by developing a comprehensive communication strategy and working with high-risk groups. They are also conducting qualitative work and surveys to understand how people feel about the vaccine, including their fears about potential exposure when receiving the vaccine in a health care setting or other distribution point. Obregon emphasized that engaging communities and parents should be a continuous focus that is embedded in the system, rather than occurring post hoc when a crisis happens.

Reflections on Session 3

Walter Orenstein, professor and associate director at the Emory Vaccine Center, reflected on the workshop’s third session. He commented that in addition to immunization mandates, there are myriad ways that the legal system can be used to enhance access, increase convenience, and remove barriers to vaccination, as demonstrated by the Vaccines for Children program

and efforts to increase vaccine delivery by pharmacists to broaden availability. Noting that no legal challenge to overturn a school mandate law has been successful thus far, he suggested those types of mandates should be used not as the starting point, but as a strategy to catch up on school children whose vaccinations have been delayed. He highlighted several lessons learned from the removal of nonmedical exemptions from vaccine mandates in California, including the importance of (1) assuring valid contraindications, (2) avoiding grandfather clauses that allow unimmunized children to stay enrolled, (3) enforcing those laws, and (4) working with provider groups and other stakeholders to bolster the political will to move these initiatives forward.

Orenstein remarked on strategies that were presented to promote parent engagement and improve parent–provider communication to shape vaccination behavior. Parental incentives are a useful tool, with some early data suggesting that the immunization bracelet being used in South Asia is promising in terms of effectiveness. Rather than assuming that providers will communicate with parents, providers should be appropriately trained in a variety of communication methods (e.g., face-to-face conversations, social media engagement) to help overcome vaccine hesitancy. Orenstein highlighted several strategies for improving communication, including the use of the presumptive approach and motivational interviewing. Rather than instructing parents that they must vaccinate their children, motivational interviewing engages with parents and reassures them that the provider understands and empathizes with them, thus building trust.

Social mobilization through engagement with individuals, communities, and trusted messengers is critical in increasing vaccine coverage both nationally and internationally, said Orenstein. He suggested testing out various communications methods rather than operating on assumptions about what is needed. Jackson’s presentation on TIP demonstrates that services can extend beyond a one-size-fits-all approach, he added. Individuals within communities can be engaged as effective messengers, as Hsu described in Washington State. Letley’s presentation highlighted how reaching out to trusted individuals within a religious community can help engage that community. Stinchfield outlined methods of addressing perceptions via reaching out to individuals and groups who are trusted within a community.

Orenstein concluded that effective vaccines have been developed and recommended, but they are only of benefit when they are administered. During the current COVID-19 pandemic, professionals must work together to advocate not only for resources to develop COVID-19 vaccines but also for resources to ensure these vaccines are delivered to the populations for whom they are recommended. He noted that even vaccinees benefit from high vaccination coverage rates because no vaccine is 100 percent effective; when everyone is vaccinated, it protects people who have vaccine failures.

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Reflections and Ways Forward

The workshop's fourth session focused on optimizing the use of vaccines. Its objectives were to discuss the impact of vaccines in mitigating emerging threats during an outbreak, to discuss approaches to strengthen public trust in science and public health programs, and to synthesize priority actions that may ensure that immunization programs reach everyone. Nicole Lurie, strategic advisor to the chief executive officer at the Coalition for Epidemic Preparedness Innovations (CEPI), gave a plenary presentation of new vaccines in the midst of an outbreak. She discussed vaccination research, lessons learned from past outbreaks, regulation and safety monitoring, and the effects of coronavirus disease 2019 (COVID-19) on vaccine development and acceptance. Lurie's plenary presentation was followed by a discussion moderated by Kent Kester of Sanofi Pasteur.

The session concluded with a panel on inoculating against misinformation and rebuilding the public's trust in science, moderated by Alison Buttenheim from the University of Pennsylvania. The panelists included Sander van der Linden, director of the Cambridge Social Decision-Making Laboratory; Ethan Lindenberger, activist; and Kasisomayajula Viswanath, Lee Kum Kee Professor of Health Communication at the Harvard T.H. Chan School of Public Health. Van der Linden discussed his work on developing the Bad News Game, a psychological vaccine against misinformation. Lindenberger discussed the need to empathize with vaccine rejectors and anti-vaccine advocates. Viswanath explored issues related to the social science approach to fighting vaccine hesitancy. The panel was followed by visionary statements on priorities in building vaccine acceptance and uptake for the next generation from Peter Hotez, professor and dean of the National School of Tropi-

cal Medicine at the Baylor College of Medicine; Narenda Arora, executive director of Inclin Trust International; Monika Naus, medical director of the Communicable Diseases and Immunization Service at the British Columbia Centre for Disease Control, Canada; and Jean-Marc Olivé, an independent consultant formerly at the World Health Organization (WHO). The workshop concluded with closing remarks from Peter Daszak, chair of the Forum on Microbial Threats and president of EcoHealth Alliance.

NEW VACCINES IN THE MIDST OF AN OUTBREAK

*Presented by Nicole Lurie, Coalition for
Epidemic Preparedness Innovations*

Lurie discussed the optimal use and vaccine confidence of a new vaccine during a global pandemic. Drawing on lessons learned from previous outbreaks, she suggested strategies for strengthening global solutions to vaccine financing, development, regulation, and distribution during epidemics and pandemics.

Collaborative Research to Respond to the COVID-19 Pandemic

Vaccines will likely be the strategy that ends the COVID-19 pandemic, said Lurie. She described the process of developing a vaccine during a pandemic as “building the plane as we are flying it,” emphasizing the difficulty of simultaneously developing vaccines and vaccination campaigns in the United States and around the world while also contending with the virus. Because there is not yet a strong vaccine candidate for COVID-19, vaccine confidence is being considered without the benefit of data on safety, efficacy, and characteristics. This dynamic poses a number of challenges to development, vaccination campaigns, and vaccine confidence, Lurie noted. In response, unprecedented global scientific collaboration is taking place in examining the disease, developing vaccines, and creating new platforms and technologies to manufacture the vaccines.

While it may seem as if all aspects of developing vaccines for this novel virus are new, the effort is actually building on many years of investments, said Lurie. This includes research on the human–animal interface and the kinds of diseases likely to affect humans, as well as how this knowledge can be applied to outbreak preparedness. Tremendous investment has been channeled into understanding the coronavirus, stemming in part from a recognition that severe acute respiratory syndrome (SARS) would eventually reemerge. In addition, investment has been made—particularly at the National Institutes of Health (NIH)—in researching prototype pathogens and the coronavirus to understand the role of the spike protein. Furthermore,

much investment and advancement in vaccine platform technologies have taken place over the past decade. These were built on the success of experience and research platforms, and they are enabling the work being carried out today, she added.

Lessons Learned from Past Outbreaks

Multiple lessons can be gleaned from the vaccine development efforts that stemmed from SARS (2003), influenza A virus subtype H1N1 (2009), Ebola virus disease (2014–2016), and Zika virus (2015) outbreaks, some of which were successful and some of which were incomplete.

Lessons from SARS (2003), Zika (2015), and Ebola Virus (2014–2016) Outbreaks

Lurie highlighted two lessons learned from the SARS, Zika, and Ebola outbreaks: getting an early start and seeing the process through to completion. In the case of both SARS and Zika, vaccine development efforts were well under way. However, the SARS outbreak ended before a vaccine was developed, and government funders and others lost interest in seeing vaccine development through to completion or to a later stage of advanced development. In the case of Zika, vaccines progressed quite far, but then the U.S. government—the primary funding source—deprioritized the effort. This has contributed to some reluctance on the part of major vaccine developers and manufacturers to begin working on a COVID-19 vaccine as soon as possible, Lurie noted. The Ebola outbreak illustrates the value of an early start, said Lurie. At the point when the outbreak had the potential to become a matter of major global concern, a vaccine candidate was already partially through the development process. Having the capability to accelerate the development of this existing candidate jump-started the creation of a vaccine, she added.

Lessons from the H1N1 Pandemic (2009)

Lurie also described several lessons learned from the development and deployment of vaccines in response to the 2009 H1N1 pandemic. The first is the value of what Lurie called “on-ramps.” The U.S. government has a framework for responding to novel pathogens, particularly influenza viruses, that involves beginning vaccine development—that is, taking an “on-ramp”—when a new strain appears. Development stops if it is determined that the pathogen does not merit further research. This may mean that development ceases after a seed strain is made or, in the case of H7N9, it may go all the way through the development process to the manufacturing and storage of bulk vaccine in case it is needed in the future. Lurie values this

approach of starting early, saying that in the midst of an outbreak one cannot make up for lost time, but one can always take an “off-ramp.” Thus, she argued that starting development early when new pathogens appear should be the default process. Development can then be stopped at whatever point it is clear that a vaccine is not needed. Early development requires that vaccine funders, especially the U.S. government but also funders from around the world, remain reliable partners to the vaccine industry, she maintained. Otherwise, industry partners feel abandoned and unwilling to risk beginning development as early the next time there is an outbreak.

The second lesson learned from the H1N1 pandemic was the value of speed, said Lurie. Efforts are under way to hasten the delivery of a COVID-19 vaccine, such as Operation Warp Speed and CEPI’s work to have vaccines manufactured before clinical trials are performed and it is known whether they work. Lurie explained these efforts are shaped by experiences with the pandemic H1N1 virus and expediting the process for influenza vaccines. Methods of making flu vaccines are well established, so it was possible to work off of earlier vaccine platforms to create an H1N1 vaccine for this strain. For instance, the U.S. Food and Drug Administration (FDA) generally agrees to license egg-based and cell-based vaccines for novel influenza vaccines as a strain change. Lurie said the current “Holy Grail” is to develop other platforms that are faster, more reliable, and pathogen-agnostic, which would enable new vaccines to be regulated as a pathogen changes. She added that the COVID-19 pandemic is providing experience with maturing platforms and ways to improve them.

Regulation and Safety Monitoring

It is important to consider regulatory alignment in planning for optimal use of and confidence in new vaccines from novel platforms while in the midst of an outbreak, said Lurie. Each country has its own regulatory system, and regulators are not always working together. In recent years, CEPI has made efforts to promote collaboration among regulators from around the world to discuss vaccines early and contribute scientific advice about how to move forward with vaccine development. During the COVID-19 outbreak, regulators have formed an international organization that includes FDA, the European Medicines Agency, Chinese regulators, regulators from African countries, and WHO.¹ In this forum, regulators have come together to share ideas about regulatory science, procedures for authorizing the use of vaccines, and approaches to vaccine manufacturing. Lurie said that if

¹ More information about the COVID-19 response from the International Coalition of Medicines Regulatory Authorities is available at <http://icmra.info/drupal/en/covid-19> (accessed February 19, 2021).

there are vaccine strains that some regulators authorize, but others do not, it could undermine vaccine confidence; this underscores the importance of continued collaboration among regulators. Such collaboration may provide a model for the future.

Safety monitoring is also critical for optimal vaccine uptake, said Lurie. In the United States, concerns have been raised about the premature authorization of a vaccine that has not adequately been tested from a safety and efficacy standpoint. Lurie said this concern is unfounded, because the vaccine development enterprise understands the importance of ensuring a vaccine's safety and testing it on many thousands of people before it is authorized for use. This level of testing is necessary for both vaccine safety and vaccine confidence, because any mistake can (1) put all other vaccine candidates that are in development at risk and (2) undermine the already precarious level of confidence in the world's entire vaccine system.

Lurie said that the most important safety work comes after a vaccine is released, whether this is post-emergency authorization or post-licensure. It is only at that point that vaccines are used in enough people to enable detection of rare adverse events that may be serious enough to merit halting the vaccine. She noted a number of advances in safety monitoring during the H1N1 pandemic, when the U.S. government used the Vaccine Safety Datalink, the Vaccine Adverse Event Reporting System (VAERS), and methods through which health care systems conduct their own surveillance for vaccine safety signals by using health information technology. Lurie suggested that given such developments, safety monitoring for a COVID-19 vaccine should be more robust than was possible a decade ago. Furthermore, she advised that continuous, clear, transparent information about adverse events following immunization be provided to the public, because there will be health events that happen by chance but are attributed to vaccines. Thus, maintaining vaccine confidence involves helping the public better understand efficacy data and safety monitoring to build confidence that vaccine information being shared is truthful.

Challenges and opportunities in vaccine development are intensified when dealing with a global pandemic, noted Lurie. She predicted that more than one COVID-19 vaccine will become available at roughly the same time. Furthermore, she anticipated that high-income countries with strong pharmacovigilance systems will likely initially receive the largest quantities of vaccine, which presents an opportunity for those countries to collaborate by using the same safety signal definitions and pooling their data to facilitate early detection of any adverse event signals. This would create a strong information base that could then be shared with countries that do not have strong pharmacovigilance systems, thus helping them strengthen their systems and understand where best to focus, while also remaining aware that they may detect different types of signals. Global collaboration on safety monitoring will be foundational for ensuring optimal uptake, vaccine confidence, and

responding to rumors and misinformation with solid, reliable, and verifiable information, Lurie said.

Coordinating COVID-19 Vaccine Development in the United States and Worldwide

Lurie noted contrasts between vaccine development in the United States and much of the rest of the world. The United States invests in systems for the basic science, surveillance, and advanced development of vaccines through the Biomedical Advanced Research and Development Authority. The U.S. Congress allocates funds for scaling up manufacturing and full-scale manufacturing; it also provides a financial guarantee to the companies that doses manufactured will be purchased. Systems developed through the U.S. Centers for Disease Control and Prevention (CDC) and in collaboration with state and local governments ultimately distribute the vaccine. Thus, the federal government provides end-to-end financing and has responsibility for pharmacovigilance systems.

Lurie said that prior to the point at which the U.S. government began backing development of a COVID-19 vaccine in earnest, CEPI examined the portfolio of vaccine candidates it had been developing before the outbreak. These included vaccine candidates for diseases that might have epidemic potential, including Middle East respiratory syndrome (MERS), and platform technologies that could be used in the event of Disease X.² Lurie noted that a host of pathogens, including Lassa, Nipah, MERS, and Disease X, are on the WHO priority list. Around January 7, 2020, just before the COVID-19 gene sequence was posted, CEPI reached out to the developers of the MERS vaccines and of the platform technologies and requested they pivot their efforts to COVID-19 as soon as the gene sequence was posted. CEPI had 2 weeks to determine how to provide these developers with the money they needed to get started. Over time, the U.S. government has invested many billions of dollars in vaccine development, while China has proceeded with its own vaccine development.

Prior to the COVID-19 pandemic, there was no global entity to enable vaccine development at the international level in the ways the United States does at the national level, such as:

- Funding phase 3 pivotal trials;
- Scaling up manufacturing capacity to produce large numbers of doses;

² More information about prioritizing diseases for research and development in emergency contexts is available at <https://www.who.int/activities/prioritizing-diseases-for-research-and-development-in-emergency-contexts> (accessed November 2, 2020).

- Making advance purchase commitments or advance market commitments to vaccine developers, which would eliminate their risk in manufacturing doses of vaccine that are not yet proven to work in clinical trials; or
- Buying vaccine and distributing it in an equitable fashion around the world.

Thus, these are all components of a global system outside of the United States that is being built during the current pandemic.

The Access to COVID Tools Accelerator (ACT Accelerator) was formed as a partnership among WHO, a number of other global organizations, and several companies. Within the ACT Accelerator, there is a vaccine pillar that is co-led by CEPI and Gavi, the Vaccine Alliance, and heavily involves WHO. Lurie said that through this partnership, the rest of the world has now created systems to finance the advanced development, scale up, and manufacture of vaccines. She added that fundraising has relied on the leadership of the European Commission. As of August 2020, CEPI, Gavi, and a host of countries were coming together to finalize agreements on how they will make advance commitments to purchase vaccines together as a large buyer coalition or as a combination of coalitions. Thereby, companies will be able to complete scale out of their vaccine or scale up of manufacturing. The manufacturing is being done with Operation Warp Speed in an effort to begin distribution around the world as soon as the trials are complete. Working with WHO, a global allocation framework is being developed to ensure that frontline workers and priority populations around the world are the first to be vaccinated. Lurie said all data and modeling indicate that vaccinating people around the world in prioritized tiers will end the pandemic and stimulate economic recovery faster than vaccinating all people in any one country.

COVID-19 Vaccine Acceptance

Global partners responsible for distributing vaccine and assisting with vaccine campaigns, especially in low-income countries, are planning and developing protocols to distribute and administer COVID-19 vaccines, said Lurie. Work is also under way around vaccine literacy, vaccine confidence, and putting systems in place to understand people's concerns and current confidence in vaccines. Lurie said that on a country-by-country and a population-by-population basis, professionals need to use everything they have learned to optimize vaccine acceptance as soon as a safe and effective vaccine is available in order to end the pandemic. This is a challenging situation, because many low-income countries have substantial morbidity and mortality from other infectious diseases. Therefore, while some countries have high enthusiasm for a global vaccination system, others have notable

hesitancy. Lurie said that CEPI is receiving questions such as “What do you do when people are more afraid of the vaccine than the disease?” While more challenges undoubtedly lie ahead, everything that can be accomplished collaboratively as a global community will set the stage for bigger, better, and faster responses in the future, said Lurie. Lurie’s hope is that in addition to scientific and regulatory collaboration spearheaded by NIH and FDA, collaboration is also ongoing regarding vaccine development and shared financing. When it comes to making vaccines available to the world, “none of us are safe until all of us are safe,” said Lurie.

Discussion

Sustainable Global Vaccine Collaboration

Given that pandemics are episodic in nature, Kester asked how truly global solutions that are equitable and well received can be sustained in a context of events that only rarely occur. In the case of Zika, interest in a vaccine evaporated as the threat lessened. He asked how CEPI, Gavi, and others can facilitate sustainable global solutions. Lurie responded that once a vaccine is started, a commitment is needed that the vaccine will be taken to a stage of development where it can be brought forward rapidly in the future if need be—this should have been done with Zika. If COVID-19 happens to disappear before a safe and effective vaccine is developed, vaccines should continue to be moved through development and a certain amount stockpiled to enable rapid response when the virus reemerges, she said.

Additionally, the COVID-19 pandemic has highlighted the need for global financing and financial preparedness. “You can’t be passing a tin cup in the middle of a pandemic,” Lurie emphasized. Once this pandemic is under control, Lurie advised global payers to come together to determine how to finance the response to a future pandemic. Regardless of the global financing system and state of financial reserves, it should be expected that a certain amount of money will be spent each year as the cost of preparedness. A system is needed in which whenever a new pathogen emerges, researchers agree to take an “on-ramp” and perform the enabling science work to determine whether a vaccine is required, then continue to perfect platforms and begin vaccine development. This keeps researchers practiced and keeps products moving forward. Funding these “on-ramps” of vaccine development should be the cost of preparedness, Lurie asserted. Even if this cost is \$10 million or even \$50 million per year, it pales in comparison to the \$350 billion in gross domestic product that is currently being lost each month because of the pandemic, she said. Currently, financing preparedness seems to be an issue even bigger than scientific preparedness and, moving forward,

it is one that must be solved by the world collectively, Lurie said. She added that being prepared is fair to companies, developers, the scientific community, and to the public. This approach could be characterized as an insurance policy in paying premiums to avoid larger issues later on, added Kester.

Lessons Learned from Ebola for Vaccine Confidence

Kester asked whether there are learnings, case studies, testimonials, or other insights—aside from what has been published—about the early use of the Ebola vaccine in health workers that can be adapted for building confidence more broadly. Lurie said the Ebola experience helped scientists realize that many people do not really understand the concept of a vaccine and what it is. Furthermore, they learned that it is possible to sit with trusted community leaders and explain how vaccines work, enabling these leaders to explain this to their communities in turn. Lurie said that fundamentally and in all parts of the world, confidence building comes from trusted community leaders understanding the vaccine process and communicating information to their populations. Lurie highlighted the practices of the United Nations Children’s Fund (UNICEF) and Médecins Sans Frontières, who took “the pulse of populations” about the Ebola outbreak and vaccine, then disseminated what they learned. This included establishing listening posts, monitoring social media in areas affected by the Ebola outbreak, and talking to people on the ground about their beliefs and what they were hearing in their communities. She said these practices were essential to the explanation and acceptance of vaccines.

To exemplify the importance and power of good science, randomized controlled trials (RCTs), and communication, Lurie shared a story of a meeting with the Secretary of the U.S. Department of Health and Human Services, NIH colleagues, and the president of Liberia. The president said that her people were reporting that the vaccine was making people go blind. This revealed that better communication was needed about how vaccines work, how Ebola affects people, and how RCTs operate. The researchers explained that it was Ebola that was causing blindness, not the vaccine. The group detailed how the RCT was set up, explaining that it was actually people in the control or placebo group who were going blind, not those who had received the vaccine. This illustrates how knowledge gaps can be bridged by helping people understand how clinical trials are designed and creating listening opportunities. She noted that every country, culture, and language will have a slightly different way of approaching this information. Therefore, anthropologists on the ground should work with communities and collect information specific to each setting. Lurie added that WHO’s approach is to send anthropologists anywhere they send epidemiologists.

Vaccine Deployment in Countries Lacking Infrastructure

Noting that financing the development, manufacturing, and deployment of vaccines has already been discussed, Kester asked how low- and middle-income countries (LMICs) with limited infrastructure could deploy the COVID-19 vaccine and adequately vaccinate their populations. Lurie suggested building on existing systems rather than trying to start from scratch. For instance, most LMICs currently have childhood vaccination programs, and the childhood vaccination rates in these countries are often higher than in the United States because of the supply chains created with support from Gavi, UNICEF, and nongovernmental organizations. Acknowledging that the system is not perfect, Lurie added that if the COVID-19 vaccine ends up requiring a –80 degrees Celsius cold chain, it is likely that only the handful of countries with this capacity as a legacy of the Ebola vaccine campaign will have that capability for the foreseeable future. Thus, planning is already under way to provide countries with technical assistance.

The H1N1 pandemic experience revealed gaps in preparedness planning, noted Lurie. During that outbreak, the United States shared a percentage of its vaccines with WHO to distribute around the world. However, many countries were not prepared to accept it nor had developed plans in place to use it. A series of planning and preparedness checklists were developed to help countries develop the logistics for their vaccination campaigns. Many LMICs receive vaccines that are paid for by Gavi; many also receive funding from the World Bank that can be used to hire staff and develop vaccine plans and campaigns. This will help build on these countries' strengths and increase their capacity moving forward, she said.

Vaccine Adverse Events

Kester noted the variety of systems in the United States and other countries for recording adverse events. With self-reporting, as used by the VAERS system, reports are not curated, and people can report medical information that may not be germane. Given the difficulty in differentiating true vaccine adverse events and events that are unrelated to vaccines, Kester asked about the strategies to instill vaccine confidence. Lurie noted that unrelated medical events are frequently attributed to vaccines by the public, such as people believing they got seasonal influenza from the vaccine. In addressing H1N1, extensive work was performed in establishing background rates of events such as Guillain-Barré syndrome, developing clear case definitions of events that might be vaccine adverse events, and then establishing background rates. Lurie said the same process needs to happen for COVID-19. She noted that CEPI has worked with the Brighton Collaboration to look at particular

types of adverse events that might be unique to COVID-19 vaccines,³ particularly in terms of either antibody-dependent enhancement or lung pathology, and then develop and disseminate those definitions. Ideally, countries would determine to use and develop a harmonized set of definitions for potential adverse events, and then commence work to understand the background rates now, before a vaccine is available. This enables the comparison of the rates of reported adverse events with normal expected background rates to determine if rates are actually increasing with the vaccine. Lurie acknowledged that communicating with the public about this is a challenge. Medical events will happen that are completely unrelated to vaccines, yet people will attribute them to the vaccine and amplify those putative associations on social media and other channels—some of which is maliciously intended. She emphasized that in addition to back-end work to maintain public confidence, front-end work is also needed to establish background rates, help people understand what they are, disseminate them, and standardize definitions. In this way, the strengths of systems in higher-income countries can be used to generate information that can be shared worldwide.

Addressing Potential COVID-19 Vaccine Failures

Given the regional, national, and global deployment needed for a COVID-19 vaccine, Kester asked about the best approach for detecting vaccine failures. In a clinical trial, the population tested is selected with demographics, ages, and medical conditions in mind. However, a global vaccine will presumably be given to all people at some point, and some failures are to be expected, as even good vaccines do not work in everyone. He asked how the strengths and weaknesses of a particular vaccine can be communicated accurately when so much misinformation is instantaneously amplified by social media. Lurie replied that this challenge will be compounded if multiple vaccines are in the field simultaneously, because the first wave of vaccines will likely have efficacy well below 100 percent. Some may even have efficacy closer to the seasonal influenza vaccine (around 50 percent). Thus, there will be breakthrough infections and failures.⁴ Researchers will need to understand whether those breakthrough infections are typical cases of COVID-19 or if they are associated with additional adverse events.

³ More information about the Brighton Collaboration is available at <https://brightoncollaboration.us> (accessed November 2, 2020).

⁴ According to the CDC definition, breakthrough infection refers to “development of a disease despite a person’s having responded to a vaccine.” See <https://www.cdc.gov/vaccines/terms/glossary.html#b> (accessed February 19, 2021).

Lurie emphasized there is no entity in the global system that is responsible for conducting or funding phase 4 (ongoing safety monitoring) studies, the burden of which will be enormous. Although there are study designs for determining failure rates, they require the ability to collect data. However, this is more easily accomplished in organized health systems where information about receipt of a vaccine can be linked to information about hospitalization or office visits for COVID-19 treatment. Countries with this level of capacity will likely need to bear the initial burden of this work, she added.

INOCULATING AGAINST MISINFORMATION AND REBUILDING THE PUBLIC'S TRUST IN SCIENCE

Panel Discussion

A Psychological Vaccine Against Misinformation

Van der Linden described the psychological vaccine technique for curbing the impacts of misinformation. Just as weakened doses of a pathogen can be injected into the human body to trigger the production of antibodies and confer resistance against infection, psychological “inoculation” exposes individuals to weakened doses of misinformation, fake news, and other techniques of deception about vaccination to create “mental antibodies”—that is, to trigger a psychological process of resisting and arguing against these deceptive techniques.

Psychological Inoculation Against Misinformation

Van der Linden explained how psychological inoculation is analogous to biological inoculation, where a psychological “vaccine” can trigger “mental antibodies” against misinformation. The psychological vaccine has both an affective basis and a cognitive basis. Recipients are warned of the impending threat to their belief systems, such as the threat of fake news; this is the affective basis. In addition, they are given preemptive refutation of harmful content. This cognitive basis has been termed “prebunking.” As opposed to debunking and fact checking, prebunking gives individuals the needed cognitive tools in advance of their exposure to harmful content. This aspect of psychological inoculation makes the analogy to physical inoculation quite apt, he said. Exposure to these psychological vaccines triggers mental antibodies that, through internal rehearsal, can increase individuals’ resistance to future exposure and persuasion attempts, thus achieving psychological inoculation. Studies have been conducted to investigate the mechanisms of these psychological processes (Cook et al., 2017), but the primary purpose of this approach is to scale up and create “heard immunity” against misinformation.

Bad News Game

The Bad News Game immerses players in a simulated social media environment, putting them in the role of a fake news producer (Vaidyanathan, 2020). Designed to expose the tricks used by fake news creators, this approach is similar to revealing how a magician's trick is performed, said van der Linden. While a person might initially be fooled by fake news, two potential approaches can expose the trick: (1) interveners can present relevant education and scientific information that refutes the fake news or (2) interveners can show how the trick is done and let the person perform the trick themselves. The latter, which he described as a more powerful experience, is the approach used in the Bad News Game to teach people about fake news.

Van der Linden explained how the Bad News Game works. The game's interface includes a follower count, which tracks the player's number of in-game social media followers, and a credibility meter. A narrator presents the player with options at each stage. These features guide the player's choices toward balancing the incentives of growing a following while maintaining some credibility. The objective of the game is to get as many followers as possible. The game offers badges for polarization, impersonation, conspiracy, trolling, emotion, and discredit. These badges are informed by the game designers' review of available literature, which revealed that these six techniques are used with great frequency. The game's first lesson is an online impersonation. Players begin by impersonating Donald Trump with a tweet stating, "After long deliberation with my generals I've decided to declare war on North Korea. #KimJungDone." Van der Linden presented an example of a simulated tweet designed to create an in-game echo chamber: "The Mainstream Media is one massive conspiracy. #FakeNews." Because the game is hosted online, it can be updated based on current events. For example, as the COVID-19 pandemic unfolded, new elements were added to the game. Official WHO tweets were added, and the game demonstrated how fake news promoters responded to real WHO tweets in an attack on WHO's official statement. A trolling tweet was added to the game that accuses WHO of conspiring to release the virus as a bioweapon. Aimed at a younger audience, the game is intended to be a humorous, sharable conversation starter. The inoculating effect of the game is represented with a badge system. As it is impossible to inoculate individuals against every instance of fake news, the game targets the underlying mechanisms of fake news so players can learn to identify them. The in-game badges are intended to reveal these underlying mechanisms of fake news.

Findings from Bad News Game Research

Before and after playing the Bad News Game, players are tested on their ability to spot misinformation techniques. Thus far, the game has collected

data from more than 15,000 people who have played the game. The first study conducted with this data found that playing the Bad News Game did not change the credibility ratings players gave for real news. In contrast, players rated fake news items containing techniques revealed in the game as being less credible (Roozenbeek and van der Linden, 2019). The effectiveness of the game was not associated with the age or political affiliation of players; playing the game resulted in a shift in ability to spot misinformation techniques. Since the initial study, RCTs have been conducted to evaluate the game, including opt-in experiments. One study found the same effect among 197 participants (Basol et al., 2020). In this study, players were not only better able to spot misinformation techniques after playing the game, they were also more confident in their ability to correctly identify fake news.

Another study evaluated the long-term effectiveness of inoculation against misinformation among 150 participants (Maertens et al., 2020). Unlike a real vaccine, psychological inoculation cannot confer lifelong immunity to misinformation.⁵ However, the effects of psychological inoculation have been shown to persist for up to 2 months. Van der Linden and his colleagues are beginning to experiment with “booster shots” by having players revisit the game to remain alert and able to spot misinformation techniques. In partnership with the United Kingdom and the Harvard Kennedy School Misinformation Review, the Bad News Game was translated into several languages and tested cross-culturally with players from around the world.⁶

In conclusion, van der Linden invoked the words of Severus Snape, a character from the *Harry Potter* series, who said that one’s “defenses must be as flexible and inventive as the arts you seek to undo” (Rowling, 2014). Especially relevant in the context of addressing misinformation, this quote applies to the new, innovative, and adaptive solutions that are needed to supplement debunking and fact checking. Van der Linden made the point that at this point he can basically predict what types of misinformation will emerge for a given topic, which then provides the ability to preemptively provide individuals with good information before exposure to misinformation, and inoculating against techniques of disinformation are examples of such innovative solutions. Constant efforts to retroactively undo the damage of misinformation and reduce vaccine hesitancy include applying these approaches to new contexts as they emerge. Van der Linden advocated for preemptive efforts to prepare the public for the release of forthcoming COVID-19 vaccines. Efforts

⁵ Van der Linden explained that this experiment had players in the control group play Tetris (Maertens et al., 2020).

⁶ More information about the work done on the Bad News Game by the Harvard Kennedy School Misinformation Review is available at <https://misinformationreview.hks.harvard.edu/article/global-vaccination-badnews> (accessed October 15, 2020).

are under way to create new games similar to the Bad News Game that specifically address issues such as COVID-19 vaccine hesitancy and COVID-19 conspiracies. The aim of these efforts is to prebunk disinformation agents and to work toward psychological herd immunity.

Empathizing with Vaccine Rejectors and Anti-Vaccine Advocates

Lindenberger shared reflections from his vaccine advocacy work and insights from his personal experience being raised by his mother, who rejected vaccines and chose not to have Lindenberger immunized as a child. He applauded the work presented by van der Linden, highlighting the importance of prebunking against misinformation and conspiracy theories of all kinds. At the age of 18, Lindenberger chose to catch up on his immunizations and began exploring the factors that lead individuals to reject vaccination. His work emphasizes the factors that lead certain people to be more susceptible to vaccine misinformation, aiming to humanize vaccine rejectors and acknowledge that many vaccine rejectors have good intentions. He explained that his experiences with misinformation have been rooted in how individuals interact with social media, along with other factors that can influence a person's exposure and reaction to misinformation. Demographic factors such as age, gender, geographic location, or education may influence the way individuals engage with and respond to misinformation. For instance, Lindenberger's mother had multiple children and did not attend college. Lindenberger suggested that these factors likely contributed to his mother's likelihood to accept anti-vaccine misinformation. Additionally, he asserted that his mother's strong maternal instincts made her susceptible to the misinformation tactics used to promote anti-vaccine information, as these often make strong emotional appeals to parents about the risks of child vaccination. He said his mother's underlying acceptance of vaccine misinformation was eventually bolstered and galvanized by her exposure to anti-vaccine misinformation on social media, and he questioned whether she may ever change her mind about vaccines. Acknowledging that powerful actors aim to promote misinformation for reasons such as monetary and societal incentives, Lindenberger said vaccine advocates should take care to be empathetic and humanize those who accept misinformation, even while combating misinformation itself.

Buttenheim asked how Lindenberger's mother might respond to the Bad News Game. Lindenberger explained that he has discussed misinformation similar to the content of the Bad News Game with his mother. For example, she has presented him with anti-vaccination videos that she found compelling in spite of containing no evidence and being full of misinformation tactics. He expressed frustration in seeing the apparent misinformation in these videos, but realized his mother was drawn to the emotional content they

contained. Rather than analyzing the video's claims, his mother responded to the revelatory and world-breaking tone and presentation of the video. His attempts to refute misinformation claims have proven ineffective with his mother, and he speculated that, as with many diseases, preventing the spread of misinformation may be far more effective than trying to "cure" misinformation. This is especially true of polarizing issues, which make it difficult for debunkers to "reach across the aisle" once misinformation creates a divide. He compared this real-life experience to the in-game experience of playing the Bad News Game and concluded that education is key for addressing misinformation.

A Social Science Approach to Fighting Vaccine Hesitancy

Considering the personal experience and the gamified approaches to curbing misinformation presented by the panelists, Bутtenheim asked how these might be folded into evidence-based campaigns to promote vaccination, especially for the COVID-19 vaccines. Viswanath said that addressing this question requires a clear understanding of the audience and the vaccine in question, adding that it is only a relatively small, although vocal, group that is fully committed to the anti-vaccine perspective. As Lindenberger described, once a person has been convinced by anti-vaccination information, they become resistant to logical arguments. Those extreme cases aside, Viswanath recommended that vaccine advocates direct efforts toward promoting childhood vaccination with skeptical parents—that is, those who are on the spectrum of vaccine hesitancy but are not yet committed to an anti-vaccination perspective. He said that the vaccine advocacy community has become the victim of its own success; as the prevalence of classic infectious diseases has decreased through vaccination, so too has visibility of these diseases. Thus, successful vaccination efforts have reduced both the perceived severity of vaccine-preventable diseases and the perceived susceptibility risk of becoming infected with these diseases. Addressing this gap between perceptions and reality is difficult. Typically, statistics have been used to communicate about the severity and susceptibility associated with these diseases, but statistics are not effective for most people. Viswanath acknowledged that even he, a social scientist, finds it difficult to process these kinds of statistics.

Preliminary findings from an ongoing survey-based study revealed that nearly 50 percent of respondents said that statistical information would not influence their medical decision making.⁷ Negative emotions are especially powerful in the decision-making process, as they can focus individuals' attention on a small set of features and are easy to retrieve, reinforcing

⁷ This preliminary finding confirms that medical decisions are influenced by emotions, an effect often called the "affect heuristic."

their impact. Anti-vaccine content can easily use the effect of negative emotions. Therefore, the challenge of promoting vaccination should be tackled emotionally, said Viswanath. By recognizing that sharing facts and statistics about adverse events is unlikely to be effective, social scientists could approach vaccine hesitancy in a way that accounts for the emotional basis for decision making. Additionally, certain ethnic groups, such as African Americans, have a history of traumatic experiences with the scientific community, and this difficult history poses a challenge to vaccine advocates.

Viswanath cited survey data suggesting that 60–70 percent of individuals would be willing to get a COVID-19 vaccine once one becomes available. However, nearly 60 percent of surveyed individuals believe they are not susceptible to COVID-19 and 63 percent of individuals believe that they would not have a severe case should they become infected. Considering the abundance of misinformation and disinformation, communications strategies explicitly addressing the issues of susceptibility and severity should be used to promote compliance with public health measures. In conclusion, Viswanath reiterated the importance of identifying the audience and goals of communication campaigns, noting a distinction between campaigns promoting vaccination and campaigns promoting support of vaccination within social circles. He suggested that these campaigns employ aggressive, evidence-based tactics, such as the approaches that have been discussed throughout the workshop.

Using Data Versus Experience to Combat Misinformation Tactics

Butenheim asked how the affect heuristic informed the design of the Bad News Game and what is known about how the specific emotional responses to disinformation differ from the responses to data. Van der Linden reiterated that presenting vaccine-hesitant individuals with data is inadequate for overcoming the emotional stories at play in their minds. Again, this points to the role of emotions in human judgment and decision making. Judgments are largely driven by experiential factors, and the affect heuristic greatly impacts the experiential system. Thus, people are primarily “experiencers,” learning through experiences. Elucidating this, he invoked the words of Mark Twain, who wrote:

A person that started in to carry a cat home by the tail was getting knowledge that was always going to be useful to him, and warn't ever going to grow dim or doubtful. (Twain, 1980)

In other words, a person who carries a cat by the tail learns something they could not have learned in another way. This illustration highlights that

experience is one of the most powerful mechanisms through which individuals learn about the world, and this can include vicarious experience, such as hearing about the bad experiences of others. The Bad News Game is intended to account for these insights and reveal the mechanisms of misinformation tactics to the players. Rather than countering false beliefs with truth, the game aims to make players aware of the tactics of misinformation that are often used to establish false beliefs. Thereby, the game can reveal to the player the ways in which they might be manipulated, potentially prompting them to reevaluate beliefs established through such manipulation. He emphasized that individuals are generally not receptive to approaches that directly target false beliefs.

Another aim of the Bad News Game is to provide a nonjudgmental environment in which players can make their own conclusions.⁸ He identified three aspects of the Bad News Game designed to achieve this. First, the messages and subjects of misinformation used within the game do not support a particular ideological message. Rather, the game allows the player to choose the subjects of misinformation used within the game, such as mocking large pharmaceutical companies or attacking the government. Allowing players to choose their own path within the game helps to lower their defenses, as players must have an attitude of openness in order for the inoculating effect of the game to be realized. Second, the game makes use of humor, including self-deprecating humor. This approach helps to diffuse the tensions that may be created by the players' perceptions of elitism, awareness that the game is intended to be educational, or from the way the game mirrors the experience of social media. Lastly, the game engages players at an experiential level. Rather than targeting players' cognition with facts, the game offers an interactive, visual experience in which players compose tweets and respond to other people, and allows them to learn through doing. This approach is more aligned with the natural learning process than the use of didactic content, said van der Linden. While individuals are capable of absorbing information from reading books or attending school, people learn to navigate the world by doing. The Bad News Game uses this insight and allows players to see how they can be manipulated through firsthand experience. Because these in-game experiences are directly related to concepts, experiences, and feelings they encounter throughout their lives, players are likely to heed the lessons of the Bad News Game. He clarified, however, that the game is not directly aimed at changing players' behaviors, and it cannot be claimed that the game has increased vaccine uptake. The game is intended to be a tool that increases awareness of misinformation and the ways in which individuals can be misled.

⁸ Van der Linden acknowledged that, while the game allows players to draw their own conclusions, it is designed to steer the players toward a particular set of conclusions.

Van der Linden remarked that his mother, like Lindenberger's, sends him online content that may be questionable. Van der Linden proposed there may be a generational element to this shared experience. In such cases, people are more receptive to a discussion of the motivations and techniques of such content than an attack on the claims made within such content. Once someone has an inkling that a piece of content has an agenda to trick or misinform the audience, they are less likely to be convinced by that content. Buttenheim commented that the experience of a family member or colleague pointing out how one has been deceived may be just as unpleasant as being confronted with facts that refute false beliefs, although this coming from a trusted source may make a difference. Van der Linden agreed that trusted sources, such as family members and other in-group individuals, have more leverage to reveal misinformation. Nonconfrontational and nonjudgmental communication are best suited to revealing and combating misinformation techniques. For example, the Bad News Game was designed to be a nonjudgmental vehicle, and it uses humor to diffuse players' potential feelings of threat. The game seems to be effective, but it may be less effective for those committed to an anti-vaccination perspective or those who do not frequently use the Internet or access information from multiple sources.

For those who will not play the Bad News Game, other methods may be used to inoculate individuals against misinformation techniques. One such method is being developed in collaboration with Google and involves short, animated videos that can be played before videos containing dubious claims. If such tools are unavailable, individuals may have to serve as nonjudgmental vehicles, engaging in a nonthreatening way to help reveal misinformation tactics to others. It may be difficult to engage without escalating, especially if individuals disagree about the subject of the misinformation. Van der Linden suggested avoiding talking down to others or making them feel unintelligent or uninformed. He also suggested the use of the Socratic method, asking questions to lead the person toward realization. These questions may include: "What is the source of the information?" and "Do you think the creator of this information may have ulterior motives?" He said that if a person answers "no" to the latter question, one might point out an affiliation between the creator of the content in question and a company to which they may be associated. If engaged in real conversation without insult, this kind of discourse may lead a person to recognize that they have been misled.

Persuasion Along the Spectrum of Hesitancy

Lindenberger highlighted the distinction between anti-vaccination advocates and those who are vaccine hesitant. The former is a small group who may be among the most difficult to reach with techniques aimed at

combating misinformation. Vaccine-hesitant individuals make up a much larger group and are more likely to be reached with such techniques. Furthermore, vaccine hesitancy is a greater threat to public health than anti-vaccination advocates, he asserted, pointing to vaccine hesitancy's inclusion as one of the top 10 threats to global health WHO identified in 2019.⁹ Lindenberger noted that vaccine hesitancy is a greater concern than fringe groups promoting radical and often conspiratorial anti-vaccination information, and these radical ideas are not the most compelling reasons for vaccine hesitancy. He believes that vaccine-hesitant individuals are more likely to have been affected by less radical ideas, such as safety concerns, questions about vaccine effectiveness, and the desire to delay or skip specific vaccines. It is these less radical, more widely held ideas that vaccination advocates should target. Fortunately, Lindenberger surmised, vaccine-hesitant individuals, who tend to have fewer radical ideas about vaccination, may be easier to reach through the techniques discussed throughout the panel than anti-vaccine advocates. As many vaccine-hesitant individuals have a sense of uncertainty, they may be receptive to questions about the sources of claims, corrections about misinformation, and other conversations about vaccination. However, there are some individuals who will never be receptive to such techniques, and vaccine advocates should consider whether the individuals they discuss vaccination with are open to having their minds changed, he said.

Van der Linden agreed, adding that individuals fall somewhere along a spectrum of vaccine hesitancy. Some are susceptible to intervention but will revert to hesitancy while others are “immune to persuasion”—that is, they will never allow themselves to be convinced. The Bad News Game is not capable of convincing those who are immune to persuasion, he said, pointing out that even the metaphor of a vaccination against misinformation may be offensive to some individuals. Some individuals simply will not be reached, but working to protect individuals from becoming vaccine hesitant remains a worthy pursuit and can target those who are hesitant but still undecided. Van der Linden has found that, similar to experimental therapeutic vaccines, the Bad News Game has some therapeutic effects and can make players less extreme in their misinformation beliefs, that is, rather than abandoning their beliefs in misinformation, they have become more reflective about their beliefs. This suggests that those who have already been exposed to misinformation can benefit retroactively from vaccination against misinformation.

⁹ More information about WHO's top 10 global health threats in 2019 is available at <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019> (accessed October 19, 2020).

Potential Risks of Revealing Misinformation Tactics

Buttenheim asked whether there may be risks associated with revealing the tricks of misinformation tactics. For instance, might the Bad News Game inadvertently teach misinformation agents how to create better misinformation? Van der Linden said that this is among the frequently asked questions about the Bad News Game, and that the game was carefully designed to avoid actually fooling players into believing in-game misinformation. Much time was spent pretesting the game's content, ensuring that the humor was appropriate and that the game's content was too ridiculous for players to actually believe. He contended the techniques exposed in the game are already being used by misinformation actors, such as those working in Russian troll farms. These misinformation actors are already aware of the techniques revealed in the Bad News Game, and they do not need to play the game to learn techniques of misinformation. He explained that there are two motives for spreading fake news: political motives and financial motives. The Bad News Game avoids incentivizing the players via these motives, and there is no financial or political aspect of the game's design. These design decisions were made in hopes of preventing players from seeing the lessons of the game as aligned with their financial or political motives.

Van der Linden acknowledged the possibility that some small number of players could take the lessons of the game and apply them in a way that was not intended. The game's developers worked to test whether this was happening. After the game went viral on Reddit, developers analyzed Reddit discussions for mentions of the game to learn what the players were saying about it. Conversations about the game reflected both positive feelings and some fears about the game. However, no conversations were found in which players discussed how the game's lessons could be used to spread fake news. He compared this concern to the adage that "teaching someone a joke does not make them a comedian," suggesting that teaching someone about misinformation tactics does not make them a misinformation agent. Similar concerns exist about meta-inoculation—that is, tactics that inoculate individuals against the effects of inoculation against misinformation—and his team is considering preemptive steps to address them, said van der Linden.

Viswanath pointed out there are various types of audiences. Many individuals do not use the Internet or do not play games on the Internet. A more nuanced view is needed to understand the spread of misinformation and how it affects social media users. If those exposed to misinformation via social media can be identified, then the tools discussed throughout this panel can be used to counter that misinformation. He pointed out that while there is much public discourse on the impact of social media, social media is not a major source of news per se. Rather, social media plays a role in reinforcing and amplifying messages that may begin in more obscure areas

of the Internet. He added that developing tools to address these amplifying effects, being aware that these tools can be a way to mainstream dis- and misinformation, and reaching those who are not engaged in social media are areas of focus moving forward.

Social Media's Impact on Misinformation and the Role of Storytelling

Buttenheim remarked that as the COVID-19 pandemic unfolded, there was much discussion of “info-demiology,” that is, who is hearing and absorbing what information, and how information is spreading. She considered the possibility of examining patients’ “social mediome,” gauging the extent to which a person gets their news from social media, as part of clinical encounters. Such investigations may help vaccination advocates tailor clinical counseling to the ideas and preconceptions of individual patients. Lindenberger reported that some of the factors influencing misinformation are able to be identified by the platform operators themselves, and recent improvements have been made in the ways social media platforms handle misinformation. These changes are relevant for mitigating the potential effects of rapid sharing and spreading of singular sources of misinformation. Furthermore, platforms such as Twitter, YouTube, and Google have been effective in minimizing the spread of certain misinformation. For instance, YouTube has de-ranked or not recommended certain videos containing misinformation, Twitter has disallowed the use of certain hashtags used to spread anti-vaccination misinformation, and Facebook does not recommend anti-vaccine groups to those not already subscribing to anti-vaccination content.

Informed by his experience with his mother, who was greatly influenced by stories, anecdotes, and testimonials, Lindenberger explained that education and storytelling are his areas of focus. Personal experiences were more compelling to his mother than the data and statistics presented by the scientific community, and this contrast likely contributed to her eventual rejection of the truth of scientific information. Numbers do not resonate with people; people resonate with people, he said. Stories, drawing on imagery and personal experiences, are a highly effective method often used throughout history in human communication. The scientific community may be undervaluing anecdotes, as anecdotes are sometimes necessary to provide a real sense that what scientists know actually happens. For instance, stories about individuals who have lost limbs to meningitis or lost family members to measles can be used in a powerful way to combat misinformation. Lindenberger explained he has chosen to study journalism in order to pursue this approach in his work.

VISIONARY STATEMENTS ON PRIORITIES IN BUILDING VACCINE ACCEPTANCE AND UPTAKE FOR THE NEXT GENERATION

Poverty, Anti-Science, and COVID-19

Presented by Peter Hotez, Baylor College of Medicine

Hotez referenced his upcoming book, *Preventing the Next Pandemic: Vaccine Diplomacy in a Time of Anti-Science*, as the basis for his visionary statement (Hotez, in press). In it, he makes the case that enormous progress has been made in vaccinating the world's children and in producing adult vaccines, attributable in large part to the work of Gavi, WHO, and UNICEF. However, Hotez asserted that over the past few years, there has been a slowing, a halting, and in some cases even a reversal of some of those global health gains. He attributed this to a constellation of social determinants, including war and political collapse, instability, urbanization, deforestation, climate change, and a rise in anti-science. Hotez identified hot spot areas which, on the surface, may not seem to have much in common: Texas and the U.S. Gulf Coast; Central Latin America; Africa; the Arabian Peninsula; and China and the Philippines. These areas are all seeing slowing or reversing of vaccination gains. Simultaneously, an unexpected level of poverty-related diseases is affecting G20 nations, said Hotez. An examination of the total number of cases of poverty-related diseases, such as leishmaniasis, Chagas disease, dengue, and tuberculosis, revealed that these are overwhelmingly infecting poor people living among the wealthy in G20 countries. Hotez mentioned that a book he recently published, *Poverty and the Impact of COVID-19*, details how COVID-19 is operating along those same principles (Hotez, 2020b); those disproportionately affected by COVID-19 include poor people living in Brazil, India, and the United States. In the United States, a significant disparity in COVID-19 cases has disproportionately impacted African American and Latino communities, particularly in Texas and in the southern United States.

Hotez said that in the midst of the pandemic, one might intuit that eagerness for a COVID-19 vaccine would lead to a retreat of the anti-vaccine movement. Instead, the movement has gained strength during the pandemic, he maintained (Hotez, 2020a).¹⁰ Hotez stated that he has been confronting the anti-vaccine movement for years, responding to their false claims that vaccines cause autism and other chronic illnesses by writing a book about his daughter with autism, *Vaccines Did Not Cause Rachel's Autism* (Hotez, 2018). During the pandemic, the anti-vaccine movement has made

¹⁰ More information about the effects of the COVID-19 pandemic on routine pediatric vaccine ordering and administration is available at <https://www.cdc.gov/mmwr/volumes/69/wr/mm6919e2.htm> (accessed November 5, 2020).

allegations against Operation Warp Speed, saying that COVID-19 vaccines are rushed, they are not adequately tested for safety, they are influenced by conflicts of interest between pharmaceutical companies and the U.S. government, and they conflict with what the movement calls an individual's "health freedom." Hotez contended that despite these allegations being untrue, the lack of messaging from the White House and Operation Warp Speed has enabled anti-vaccine groups, who are now expanding their remit to campaign against masks and contact tracing. Although substantial progress is being made on vaccines, Hotez said that an epic struggle is on the horizon. On one hand, he anticipates there will be multiple COVID-19 vaccines coming out in 2021, including a new recombinant vaccine for COVID-19 that is currently in accelerated production in India with Biological E, Ltd. (Hyderabad, India).¹¹ On the other hand, the aggressive forces of poverty, climate change, war, political collapse, urbanization, and anti-science must be countered.

Vaccine Myths, Religion, and Declining Coverage Rates in India and Indonesia

Presented by Narendra Arora, Inclen

Arora recalled that in 1997, still the early days of polio eradication in India, the vaccination program was just being rolled out. During a nation-wide evaluation of the program at that time, Arora found a cluster of 20–25 homes in a small district of southern India who were refusing to take the vaccine. This community, a religious group, cited concerns about the polio vaccine causing sterility. Arora said this information was shared with the system, but not much attention was given to the matter. However, within the following 4 or 5 years, it became clear this hesitancy was a pan-Indian issue that currently affects the remaining polio-endemic areas.

According to Arora, in 2017–2018, a wide-age immunization campaign for measles and rubella was conducted in India, with almost 450 million children under the age of 15 being immunized. Initially, in South India a belief that the measles, mumps, and rubella (MMR) vaccine caused autism affected uptake. While the vaccination coverage rate in South India had been at 90–95 percent, it fell to around 30 percent. Special communications strategies helped rates recover in this region. However, around the same time, similar vaccine hesitancy and refusal issues emerged in a wide-age MMR immunization campaign in Indonesia. Within 4–6 months, an additional challenge emerged when a religious group began asking for a government

¹¹ More information about Biological E is available at <https://www.biologicale.com> (accessed November 5, 2020).

certification that vaccines are halal. Arora said that in the past 2–3 years, the vaccination program in Indonesia has been waxing and waning. A recent evaluation of Indonesia’s National Immunization Technical Advisory Group immunization program and another vaccine program indicated that the downward trend persists.

A mechanism has developed in some communities requiring vaccines to undergo religious screening and approval, noted Arora.¹² In trying to address misinformation from anti-vaccine groups, the root cause of its spread has been considered, and the scientific logic and reasons for it have been explored. However, Arora emphasized, a time may come in the near future in which communication alone is no longer effective in meeting this challenge, and a different kind of strategy is needed. He suggested that when vaccines have to undergo a filter other than national regulatory authorities—such as by requiring some sort of religious screening or approval—new strategies to address this challenge will be needed to prevent the spread of vaccine refusal.

Innovative Approaches to Improving Vaccine Uptake

Presented by Monika Naus, British Columbia Centre for Disease Control

Naus addressed current trends in British Columbia. Canada has a publicly funded national immunization program that is managed, along with health care services, at the provincial and territorial level. She perceives Canada to have an east-to-west gradient in terms of vaccine acceptance, with the highest levels of vaccine uptake in the Maritimes region in the eastern part of the country. British Columbia is in the west and has approximately 5.1 million inhabitants. It uses a mixed delivery model in which both physicians and public health practitioners, and increasingly pharmacists as well, are responsible for immunization services. In contrast, immunizations are delivered exclusively via public health in the Maritimes, and especially in Newfoundland where vaccine uptake is highest.

Naus said that as new immunizers enter the immunization service delivery arena, some moral panic has occurred among public health practitioners, who may have different models of care delivery. A growing number of vaccines requires confidence to be maintained in older vaccines and simultaneously established during the introduction of new vaccines developed through novel technologies. New vaccines may have target populations that are less familiar, such as pregnant women. It is increasingly recognized that not all vaccines are perceived the same way. For instance, the challenges in promoting the use of

¹² Arora highlighted the parallels of this with the experience of the Somali American communities in Minnesota that was discussed by Dr. Stinchfield earlier.

human papillomavirus vaccines are different than those used with bacterial meningitis vaccines. Gaps in primary care must also be addressed, she said.

In British Columbia, approximately 20 percent of residents are unattached to a family doctor, with the use of walk-in clinics increasing. This reduces the ability to have a relationship with a trusted health care provider, which Naus added has been repeatedly identified at this workshop as the most important driver of vaccine acceptance. She said research is needed to determine whether it is possible to establish that level of trust quickly with a provider one is seeing for the first time at any given visit. Efficiencies also need to be developed, as immunization is a public health program that ultimately must be delivered on a one-on-one basis; it is not possible to mass distribute vaccines such as by putting it in the water supply.

Naus highlighted some innovative efforts that have been made in Canada in recent years. Paul Bramadat, professor of religious studies at the University of Victoria, Canada, collaborated with a number of contributors from anthropology, history, psychology, behavioral science, law, family medicine, pediatrics, epidemiology, regulation, and public health to create the volume *Public Health in the Age of Anxiety: Religious and Cultural Roots of Vaccine Hesitancy in Canada* (Bramadat et al., 2017). Naus said the religious and cultural aspects of vaccine hesitancy are an increasingly important area of focus, and this book outlines the broader context, varied perspectives, and larger societal influences that have led to the current crisis of trust and truth, relativism in expertise, and regulatory acquiescence to public demand for homeopathy.

Other efforts include ImmunizeBC posting personal accounts of death and illness caused by infection from vaccine-preventable disease.¹³ These include a video about Leo Chan, a young man who died of serogroup Y meningococcal disease at age 19. The clip features a photo taken of Leo Chan with Canadian Prime Minister Justin Trudeau. Naus described that public health is beginning to embrace the power of the narrative to engage human emotions, to “speak to the elephant in our brains and not just the rider.”¹⁴ She acknowledged this can be uncomfortable for scientists who have been trained to speak about evidence and avoid anecdotal information.

A third edition of an immunization communication tool has been released in British Columbia and has been deployed in other jurisdictions.¹⁵

¹³ More information about ImmunizeBC is available at <https://immunizebc.ca/stories> (accessed November 5, 2020).

¹⁴ This concept is from Jonathan Haidt’s book *The Happiness Hypothesis: Finding Modern Truths in Ancient Wisdom* (2006).

¹⁵ More information about ImmunizeBC’s Immunization Communication Tool for Immunizers is available at http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Immunization/Vaccine%20Safety/BCCDCICT_300315.pdf (accessed November 5, 2020).

It assists immunizers in having difficult conversations with parents in terms of how to approach these discussions and provides information for answering myriad questions. Naus noted that the third addition introduces motivational interviewing as a potentially successful way to have these conversations. Lastly, evidence-based tools for addressing the pain associated with immunization are being used.¹⁶ These are focused on children and improve the experience of pain and reduce anxieties and needle phobias.

The goal of all public health immunization programs is to achieve and maintain high levels of vaccine uptake; thus, the slowness of growth or stagnation of coverage rates has been demoralizing for public health, Naus described. While the Canadian national coverage goals for almost all vaccines are around 95 percent, almost no jurisdiction has achieved these rates, and in British Columbia the 2018 coverage rate for children up to date on vaccines by their second birthday was 74.3 percent.¹⁷ Naus noted that despite the vaccination rates, disease control efforts have been effective. Many of those who are unvaccinated are clustered geographically by beliefs, both religious and nonreligious. Despite a large measles outbreak in 2014 with more than 600 cases, there was no transmission outside of the community. Naus added that for all children, the percentage that are unvaccinated is about 1 percent.

Naus pointed out that immunization registries enable researchers to use geographic information system mapping and Tableau to demonstrate where vulnerable populations are located.¹⁸ In 2019, prior to the COVID-19 lockdowns and travel restrictions, several importations of measles into British Columbia occurred (BC Centre for Disease Control, 2019). One of these resulted from three unvaccinated teenage siblings who traveled to Southeast Asia and returned with measles. This resulted in a relatively small outbreak within households and two schools, causing 10 additional confirmed cases. Intense media scrutiny of measles followed the outbreak, which was concurrent with, but unrelated to, several outbreaks in the United States. This media attention and public concern led to large-scale policy changes, including a 3-month catch-up program of MMR. Additionally, a Vaccination Status Reporting Regulation involving school mandates was passed for the

¹⁶ More information about support tools to improve students' experience of school-based vaccines is available at http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Immunization/Vaccine%20Safety/BCCDCICT_300315.pdf (accessed November 5, 2020).

¹⁷ More information about the BC Centre for Disease Control Childhood Immunization Coverage Dashboard is available at <http://www.bccdc.ca/health-professionals/data-reports/childhood-immunization-coverage-dashboard> (accessed November 5, 2020).

¹⁸ More information about Tableau is available at <https://www.tableau.com/solutions/maps> (accessed November 5, 2020).

first time in British Columbia,¹⁹ where there had previously been reluctance to introduce mandates. Naus said that the takeaway from this outbreak response is that opportunities to move the agenda ahead should be taken advantage of when they present themselves.

Naus also highlighted a platform called Kids Boost Immunity that has been launched in many schools throughout Canada.²⁰ Using a gaming platform, it engages the next generation, Gen Z, with online education that addresses health literacy regarding vaccines, several aspects of school curriculum, and critical thinking skills including critically appraising misinformation, Naus detailed. Children are motivated through a gaming platform with leaderboards to track student learning outcomes and encourage friendly competitions. Pilot evaluations have indicated improved knowledge and increased support for immunization among students, while also meeting the needs of teachers. Now supported by the Public Health Agency of Canada, other countries are showing interest in the platform, she added.

Referencing a print by the British caricaturist James Gillray of a crowd developing bovine traits after cowpox vaccine, Naus remarked that vaccine misinformation and panic about vaccines have been around for a very long time. She said playing the “long game” is needed, and cited a prediction from Paul Bramadat, director of the Centre for Studies in Religion and Society at the University of Victoria, Canada, that moral panic will fade away. COVID-19 vaccines provide the opportunity to move ahead on these issues, she suggested. For example, mask wearing during the pandemic suggests that the public is more ready to accept new ideas than might be assumed. Additionally, the “silent majority” of people, including children and young people, are supportive of immunization, and they need safe ways to have immunization conversations. Furthermore, the needs at the population level, group level, and at the individual level must be met, engaging immunizers of all types through innovative approaches while continuing to build infrastructure, including immunization registries, information systems, and efficiencies. Naus noted her appreciation of the ability that web interfaces like Zoom provide in spreading information via forums, which enables the sharing of information and successful strategies and avoiding reinventing the wheel. Lastly, Naus noted the similarities of vaccine hesitancy issues across the globe and the potentially wide applicability of these tools and strategies, mentioning that vaccine hesitancy often stems from affirmation

¹⁹ More information on Vaccine Status Reporting Regulation in British Columbia is available at https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/146_2019 (accessed December 18, 2020)

²⁰ More information about Kids Boost Immunity is available at <https://www.kidsboostimmunity.com> (accessed November 5, 2020).

of the wonders of the body, of nonviolence, and of universal harmony and peace; some of the issues related to vaccine hesitancy are coming from a good place.

Community Polio Vaccination Efforts in Pakistan

Presented by Jean-Marc Olivé, Independent Consultant

Olivé spoke of his work supporting immunization in Pakistan in the past 8 years, specifically in efforts to increase acceptance of oral polio vaccine in the most resilient reservoir. He noted that Pakistan and Afghanistan are the last two global reservoirs of wild polio virus. In Pakistan, challenges to vaccine coverage include both access and demand issues. Approximately 61 percent of the nation's population live in rural areas, and less than 50 percent of people in Pakistan have access to basic services. While the national diphtheria, tetanus, and pertussis (DPT) vaccine coverage rate is at 75 percent, regional rates vary greatly, ranging from 89 percent to 37 percent, depending on the province. Similar disparities exist between different ethnic groups. This is particularly true in Karachi, one of the most resilient polio reservoirs. A 2014 study conducted by the Aga Khan University indicated the overall DPT dose 3 coverage rate in Karachi was around 75 percent, the same as the national coverage level (Siddiqui et al., 2014). However, variance was seen in ethnic groups. Whereas 82 percent of the Punjabi speaking population was immunized, these rates fell to 67 percent for Pashtun speakers and 48 percent for the Bengali-speaking population.

The Pashtun-speaking population accounts for one-third of the 14,000 non-polio acute flaccid paralysis cases reported annually and two-thirds of the wild polio virus cases, Olivé reported. He described the Pashtun-speaking population as very traditional, relatively closed, and difficult to reach due to constant movement between Pakistan and Afghanistan. He added that it can be challenging for outsiders to develop trust with this community. Repeated national and subnational immunization days are organized, often on a monthly basis, with coverage averaging 95 percent. Yet, these efforts have not been able to compensate for the poor level of basic routine protection, and wild polio virus transmission has thus never been interrupted.

Efforts were initiated to map and refer children identified as previously having received a vaccination during an oral polio vaccine campaign. However, Olivé said it was soon realized that the essential immunization services did not have the capacity to access and vaccinate these children, as they could offer doses of routine vaccination to only 30 percent of them. In response, polio eradication was integrated into the national essential immunization program, and it was provided with additional funding, making the program more financially sustainable. With increased intensity of the vaccination

campaign, stronger refusal and resentment against polio vaccine emerged, Olivé described. In response to repeated visits from campaign workers, community households complained that workers were always knocking on their doors offering only polio drops and ignoring all their other problems. Lacking access to water, sanitation, school, and basic services, some community members resented that vaccines were the only service being offered.

Olivé said that in order to enhance acceptance of vaccination offered through campaigns of essential immunization services, specific communities must be listened to and given attention. He stated that to build the confidence in the community, proper health services must first be established. Steps to address needs beyond vaccination were taken in a higher-risk community, including opening a new, revamped facility, approaching human resource issues as a lack of accountability, and addressing shortages of female health workers and staff able to speak Pashtun. This was done with the participation of local nongovernmental organizations. Olivé said that with the revamped, newly created health facility, an integrated service flow was established, directing children from birth registration to Expanded Programme on Immunization screening, nutrition screening, administering necessary vaccines, nutrition counseling, providing needed food supplements, and finally reaching the outpatient clinic as a final step in getting needed medicine. Integrated outreach services were also organized to bring health services closer to the community, including vaccination, Child Health Day, referrals for nutrition problems, promotion of breastfeeding, and birth registration. Additionally, engagement with the community involved installing a filtration station and supporting waste management, he added.

Efforts in this specific community resulted in significant increases in coverage. According to Olivé, the DPT 2018 coverage rate of 17 percent more than doubled to 38 percent in 2019, and inactivated polio vaccine moved from 17 to 42 percent. Because of the COVID-19 pandemic, progress has halted, yet the figures have not returned to the 2018 rates. Olivé was hopeful that the provision of integrated service will improve community conditions and, by extension, trust in the health system and positive perception toward vaccination. Ultimately, polio vaccination will enable the final eradication of wild polio virus circulating in these remaining persistent reservoirs, he concluded.

DISCUSSION

Addressing Vaccine Acceptance During the COVID-19 Pandemic

Given the decline in immunization services during the COVID-19 pandemic, and knowing that efforts will need to be intensified in order to bring coverage rates to pre-pandemic levels, Cohn asked the panelists

about opportunities that may emerge from the pandemic in terms of vaccine acceptance and coverage rates. Hotez replied that this is a troubling time. CDC has reported a fairly steep decline in MMR vaccination coverage in the United States owing to a previous emergency order.²¹ While the MMR coverage rate is beginning to recover, Hotez stated that he is concerned it will not return to full capacity because of the aggressive efforts of the anti-vaccine movement. He suggested a worst-case scenario of contending with COVID-19, influenza, and possibly measles concurrently. The opportunity lies in redoubling efforts around vaccine advocacy. Hotez called for an open and expanded vaccine advocacy campaign in the United States in which COVID-19 vaccinations should be integrated into the messaging about other types of vaccinations.

In Canada, COVID-19 has brought many “talking heads into the sphere,” said Naus. In addition to leaders at the national level and provincial health officers, family doctors, infectious disease physicians, and others are providing good information to the public via media interviews and other platforms. This is an opportunity to be more transparent and to engage a broader segment of the immunizer and health workforce in answering questions from the public. This includes professionals who actually speak with patients on the frontline far more than immunizing managers might, as public health experts often work behind the scenes in planning and policy, Naus said. Thus, she finds this development to be useful and productive. Furthermore, she emphasized the need to be more transparent with information as it becomes available to experts. While the amount of information coming out in real time can seem overwhelming, opportunities should be seized to frame this information and disseminate it in a timely fashion. She maintained that in British Columbia, repeated surveys show that vaccine safety is a key driver of decision making for parents who choose not to vaccinate—not access issues, which have largely been addressed. The likelihood that multiple COVID-19 vaccines are forthcoming could present an opportunity for researchers to share how they arrive at information about vaccine safety.

Arora noted that the COVID-19 pandemic caused substantial disruption to the health system in general and vaccine coverage decreased as immunization services were halted. However, in India, immunization services have been used as an entry point to reengineer and rebuild the health system. Vaccine acceptance has been high, particularly in the context of community expectations for an upcoming COVID-19 vaccine. To address the challenge of meeting the public’s expectations for the efficacy and safety of COVID-19 vaccines, he suggested that the scientific and public health communities should develop a transparent and proactive communication strategy.

²¹ See <https://www.cdc.gov/mmwr/volumes/69/wr/mm6919e2.htm> (accessed May 24, 2021).

Olivé said the pandemic has brought an opportunity to raise vaccine coverage rates in general. In polio-endemic countries, the polio infrastructure has been used to control the COVID-19 outbreak via surveillance, contact tracing, and delivering messages to the population regarding distancing, safety measures, and handwashing. All of this has been done by polio and health center staff. In going house to house, communities have come to realize that vaccinators have something to offer other than vaccine drops. Thus, Olivé was optimistic this will strengthen the acceptance of vaccination in the community. He noted that during recent national immunization days in Pakistan, the uptake of the polio vaccine seemed to have increased to levels it had achieved in the past.

Transparency and Data Communication

In the context of misinformation, Cohn asked how vaccine safety monitoring and data can be communicated to the public in a transparent way that introduces confidence. Arora responded that in India, the national Adverse Events Following Immunization (AEFI) committee was secretive and did not share causality assessment findings, which encouraged the anti-vaccine lobby and led to negative press coverage of vaccines. When he chaired the national AEFI committee, all causality assessment data were made publicly available—including cases of serious and severe adverse events and their causality—which deflated the anti-vaccine lobby because the press stopped covering the topic. Arora noted this type of transparency was particularly relevant in relation to the pentavalent vaccine. The anti-vaccine lobby was attributing sudden infant deaths to the pentavalent vaccine, but transparency via providing data prevented the lobby from gaining traction.

Discussions around COVID-19 vaccines have revealed that the American public does not realize how robust the vaccine safety monitoring system is, said Hotez. The public in the United States does not understand what CDC and FDA do, how they conduct phase 3 trials, what the Vaccines and Related Biological Products Advisory Committee and WHO's Advisory Committee on Immunization Practices are, or the monitoring conducted after a vaccine is released via VAERS, the Vaccine Safety Datalink, and at least two other systems, Hotez contended. While the vaccine safety monitoring systems in the United States are some of the most robust the world has ever seen, the American public is hearing about them for the first time, underscoring the need to build awareness. Olivé added that in developing countries, all adverse events related to immunization should be communicated by the government. Experts should share both what is known and what is not known; the media should also receive education so they can report these stories more constructively.

Building Trust Around Vaccination

Noting the time-intensive nature of gaining religious approval and establishing trust with patients, Cohn asked about the feasibility of approaching each of the vast number of religious leaders to gain their approval for their constituents to receive vaccines. Furthermore, as health care providers have increasingly limited time with their patients, Cohn asked about ways to institutionalize trust. The patient–provider interaction is critical in maintaining trust, but she asked whether trust can be built with communities and individuals outside of systems that use a one-by-one approach. Arora replied that the issue of institutional versus individual trust cannot be addressed by technical or communication experts alone—it also requires bureaucratic and political leadership. These efforts should span the institutional and community levels in addition to the individual and household levels, he asserted.

Hotez remarked that the bandwidth of anti-vaccine groups is increasing on the Internet and on social media. Thus, when parents try to find information on the Internet, they are often inundated with misinformation. Experts engage in much discussion about how to refine and improve messaging, but increasingly this message seems to be “a message in a bottle in the Atlantic Ocean,” he said. As misinformation continues to become more dominant, a more proactive approach to removing it is warranted. Arora added that a single statement in the United States associating vaccine with autism can cause much damage, so misinformation needs to be tackled at various levels to make an impact.

Cohn closed the discussion by asking each participant to provide one word that participants should take from these sessions to integrate into the way they approach increasing vaccine confidence in the communities where they live and work. Naus replied, “multidisciplinary collaboration.” Hotez contributed, “track record,” noting the incredible global and U.S. national track record of success in vaccine safety. Arora said, “honest and proactive.” Olivé offered, “build trust.”

CLOSING REMARKS

Daszak said that the issue of vaccine hesitancy is at the core of the complexity of the issues faced by global health and national public health. Health and choices around health are deeply personal issues for everyone. However, in the context of vaccination, those individual choices affect everyone—more so than any other health choice—which is the dilemma at hand. He highlighted the role of building trust with people who do not agree about this issue and with people who have been given misinformation by willful organizations in a nefarious way, persuading them not to take vaccines when it is for their benefit. The workshop spotlighted examples of solutions to

building trust in those communities, including activism and governmental information and communication. Everything points to openness, honesty, and transparency in how professionals communicate, Daszak noted, and to do these things frequently. When misinformation is presented it should be approached and confronted, sometimes via forceful correction and sometimes sensitively. The COVID-19 pandemic has taught the world that each individual's actions and choices directly affect other people in their homes, neighborhoods, communities, and beyond. Vaccine hesitancy is part of that lesson. Daszak was optimistic that once COVID-19 vaccines are available and government campaigns to promote uptake of these vaccines are under way, a future will emerge in which the public is better informed and everybody understands how individual actions affect everyone.

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Appendix A

Workshop Statement of Task

A planning committee of the National Academies of Sciences, Engineering, and Medicine will organize a workshop series to examine the current state of vaccine-preventable diseases and the impact of vaccine access and hesitancy globally, and the multidimensional drivers and impacts of declining vaccine confidence. The in-person workshop will explore health systems, research opportunities, communication strategies, and policies that could be considered to address access, perceptions, attitudes, and behaviors toward vaccination.

The workshop series will feature invited presentations and discussions on the following topics:

- The global impact of declining immunization rates on vaccine-preventable diseases from lack of access and confidence;
- Trends and indicators to monitor attitudes surrounding vaccine safety and efficacy, including a focus on regional and cultural differences;
- The complex determinants of vaccination that hinder or promote vaccine uptake;
- The role of health systems and professionals in improving access, influencing vaccine behavior, protecting at-risk communities from vaccine-preventable disease outbreaks, and preserving and building confidence in immunization strategies and practices;
- The role of media, anti-vaccine networks, and online misinformation in reinforcing anxieties about vaccine safety and drivers of vaccine hesitancy;

- Strategies to enhance community-based approaches and community engagement efforts for improving access and reducing vaccine hesitancy;
- Communication approaches that would help assuage anxieties about vaccine safety and strengthen public trust in science and health professionals;
- The ethics and effectiveness of legislation that aim to address vaccine hesitancy; and
- Potential priority actions as well as partnerships and collaborations among policy makers, health professionals, national and international health organizations, parents, and community groups to increase immunization access and vaccine confidence.

Speakers and discussants will contribute perspectives from government, academia, private, and nonprofit sectors. The planning committee will organize the workshop series, select and invite speakers and discussants, and moderate the discussions. A proceedings of the presentations and discussions will be prepared by a designated rapporteur in accordance with institutional guidelines.

Appendix B

Workshop Agenda

The Critical Public Health Value of Vaccines—
Tackling Issues of Access and Hesitancy: A Virtual Meeting

MONDAY, AUGUST 17, 2020

11:00 a.m. ET Welcome Remarks

Peter Daszak, EcoHealth Alliance

Workshop Overview and Goals

Heidi Larson, Vaccine Confidence Project

Keynote Addresses

The Global Impact of COVID-19 on Vaccination Uptake
and Access

Ann Lindstrand, Department of Immunization and Bio-
logicals, World Health Organization

The Global State of Vaccine Confidence: How Do We
Enhance the Uptake of Vaccines?

Saad B. Omer, Yale Institute for Global Health

11:45 a.m. Q&A

**Session I: Improving Access and
Closing the Global Immunization Gap**

Noni MacDonald, Dalhousie University, *Moderator*

12:00 p.m. Applying an Equity Lens in Immunization to Close the
Global Immunization Gap
Anuradha Gupta, Gavi, the Vaccine Alliance

Reducing Barriers and Increasing Vaccine Uptake
Litjen (L. J.) Tan, Immunization Action Coalition

Case Presentations
Using mHealth Interventions to Improve Vaccination
Coverage
Momin Abdul Kazi, Aga Khan University, Pakistan

The Role of Community-Based Pharmacy Interventions in
Increasing Vaccine Access
Jeffery Goad, Department of Pharmacy Practice,
Chapman University School of Pharmacy

1:00 p.m. Q&A

1:45 p.m. Observations from Day 1
Heidi Larson, Vaccine Confidence Project

2:00 p.m. Adjourn

TUESDAY, AUGUST 18, 2020

**Session II: Assessing Global and Local Drivers of
Vaccine Hesitancy**

10:00 a.m. ET Welcome and Recap of Day 1
Matthew Zahn, Orange County Health Care Agency

Alison Bутtenheim, University of Pennsylvania,
Moderator

Case Presentation

Vaccine-Attributable Severe Dengue in the Philippines and the Impact on National Immunization Programs
Stefan Flasche, London School of Hygiene & Tropical Medicine

Measuring Behavioral and Social Drivers of Vaccination
Julie Leask, University of Sydney, Australia

Understanding Drivers of Vaccine Hesitancy
Julie Bettinger, Vaccine Evaluation Center, The University of British Columbia

The Increasing Vaccination Model
Noel Brewer, Gillings School of Global Public Health and Lineberger Comprehensive Cancer Center, University of North Carolina

11:00 a.m. Q&A

11:45 a.m. Observations from Day 2
Matthew Zahn, Orange County Health Care Agency

12:00 p.m. Adjourn

WEDNESDAY, AUGUST 19, 2020

Session III: Employing a Systems Approach to Building Confidence and Increasing Uptake

Part A:

10:00 a.m. ET Welcome and Recap of Day 2
Walter Orenstein, Emory Vaccine Center

Chandy C. John, Indiana University School of Medicine,
Moderator

Legal Approaches to Promoting Parental Compliance with Childhood Immunization Recommendations
Dorit Reiss, University of California Hastings College of the Law

Impact of Eliminating Nonmedical Exemptions in California

Michelle Mello, Stanford University

Harnessing Cultural Insights to Increase Vaccination Uptake and Compliance

Dan Carucci, McCann Health

The Role of Physicians in Building Vaccine Confidence and Acceptance

Todd Wolynn, Kids Plus Pediatrics

Strategies for Improving Health Care Providers' Communication About Vaccination

Sean O'Leary, University of Colorado Denver

12:00 p.m.

Q&A

Part B:

Rafael Obregon, United Nations Children's Fund, Paraguay, *Moderator*

12:30 p.m.

Social Mobilization as a Strategy to Increase Vaccine Acceptance and Uptake

Mohamed Jalloh, U.S. Centers for Disease Control and Prevention

Adaptation of the COM-B Model to Increase Vaccination Acceptance and Uptake: The Tailoring Immunization Programmes Approach

Catherine Jackson, Valid Research Limited

The Immunity Community: A Community Engagement Strategy to Boost Vaccine Confidence

Clarissa Hsu, Kaiser Permanente Washington Health Research Institute

Engaging with Faith Communities to Increase Vaccine Acceptance and Uptake: A Charedi Orthodox Jewish Community Example

Louise Letley, Public Health England

Engaging with Immigrant Communities to Increase Vaccine Acceptance and Uptake: A Somali American Community Example
Patricia (Patsy) Stinchfield, Children’s Minnesota

1:25 p.m. Q&A

1:55 p.m. Observations from Day 3
Walter Orenstein, Emory Vaccine Center

2:00 p.m. Adjourn

THURSDAY, AUGUST 20, 2020

Session IV: Moving Forward: Optimizing the Utilization of Vaccines

Part A:

11:00 a.m. ET Welcome and Recap of Day 3
Kent Kester, Sanofi Pasteur

Kent Kester, Sanofi Pasteur, *Moderator*

11:10 a.m. Plenary Presentation
 New Vaccines in the Midst of an Outbreak
Nicole Lurie, Coalition for Epidemic Preparedness Innovations

11:25 a.m. Q&A

Part B:

Panel on Inoculating Against Misinformation and Rebuilding the Public’s Trust in Science
Alison Buttenheim, University of Pennsylvania,
Moderator

11:45 a.m. **Sander van der Linden**, Cambridge Social Decision-Making Laboratory
Imran Khan, Wellcome Trust
Ethan Lindenberger, Activist
Kasisomayajula Viswanath, Harvard T.H. Chan School of Public Health

Visionary Statements of Priorities in Building Vaccine
Acceptance and Uptake for the Next Generation
Amanda Cohn, U.S. Centers for Disease Control and
Prevention, *Moderator*

- 12:30 p.m. **Peter Hotez**, Baylor College of Medicine
 Narendra Arora, Inclen
 Monika Naus, Communicable Diseases and
 Immunization Service, British Columbia Centre for
 Disease Control
 Jean-Marc Olivé, Independent Consultant
- 12:55 p.m. Panel Discussion and Audience Q&A
- 1:20 p.m. Closing Remarks
 Peter Daszak, EcoHealth Alliance
- 1:30 p.m. Adjourn

Appendix C

Speaker and Moderator Biographies

Narendra Kumar Arora, M.B.B.S., M.D., is a pediatrician and a public health expert. He obtained his M.B.B.S. (1976) and M.D. (1979) from the All India Institute of Medical Science (AIIMS) New Delhi. He was the recipient of the Indian Council of Medical Research (ICMR) Talent Search Scheme to pursue his post-graduation and subsequent fellowship training. Dr. Arora was instrumental in establishing the Pediatric Gastroenterology and Hepatology Division at AIIMS New Delhi and was a pioneer in promoting this pediatric super-specialty in India. He received his master's training in clinical epidemiology and biostatistics from the Centre for Clinical Epidemiology and Biostatistics, University of New South Wales, under the Rockefeller International Clinical Epidemiology Network (INCLEN) Fellowship program in 1993. Dr. Arora joined the Faculty of AIIMS New Delhi in 1983 and left in 2005 to join the INCLEN Trust International as the global executive director. In 2018, the Government of India Ministry of Health and Family Welfare (MOHFW) nominated him as the president of AIIMS Patna and AIIMS Deoghar.

Dr. Arora has had an extensive academic and research career, having made major contributions to the immunization sector at both national and global levels. He has been working for the immunization of Indian children through a series of large multi-center studies that address performance of pulse polio immunization programs, injection practices, and safety in India, the safety of vaccines administered under the Universal Immunisation Programme (Government of India), including Pentavalent, and cold chain infrastructure in the country. He has also provided leadership to several national policy-making bodies, including the National Adverse Event Fol-

lowing Immunization Committee Expert Group for the rollout of rotavirus vaccine and pneumococcal vaccines; the Maternal and Child Health Services (Government of India) steering group of ICMR; and the Department of Biotechnology (DBT) (Government of India) Biopharma Mission, DBT Scientific and Technical Advisory Group. Dr. Arora has been a member of MOHFW, ICMR, and DBT for the past two decades. He has served as the chair of the National Certification Committee for Polio Eradication since 2014, and as the chair of the National Verification Committee for Measles, Rubella, and CRS. He has been a member of the National Technical Advisory Group for Immunization (India) since 2004.

Dr. Arora is credited on more than 200 research papers and is the recipient of numerous academic awards, including the Late Honorary Surgical Commander Dr. Shantilal C. Sheth Oration at PEDICON 2017, the Kerala Health Sciences University Oration (2017), and the Yogamaya Devi Award (2019) from the Maharashtra Association for the Cultivation of Science (Pune).

Julie Bettinger, Ph.D., M.P.H., is an associate professor at the Vaccine Evaluation Center in the Department of Pediatrics at The University of British Columbia. She was trained in infectious disease epidemiology and public health at Johns Hopkins University in Baltimore, Maryland. Her research interests include vaccine safety and vaccine-preventable diseases (specifically meningococcal and pneumococcal invasive infections), as well as attitudes and beliefs around immunization uptake and use. She is the epidemiologist and the data center director for the Canadian Immunization Monitoring Program ACTive, an active surveillance network for vaccine-preventable diseases and vaccine-adverse events in 12 tertiary care pediatric hospitals across Canada. Dr. Bettinger is also the lead investigator for the Canadian National Vaccine Safety network, which conducts influenza vaccine safety monitoring in more than 40,000 Canadians each year.

Dr. Bettinger's research addresses key questions about vaccines and immunization programs to ensure optimal disease protection in the population. She uses quantitative and qualitative methods to address important questions about vaccine use across the life cycle of provincial and national immunization programs. By providing a clear understanding of the epidemiology of vaccine-preventable diseases, her research enables further study of the factors (social, cultural, environmental, microbiological, and economic) that can result in suboptimal immunization and poor protection against these diseases at a population level. Her work is featured in publications such as the *Pediatric Infectious Disease Journal*, *Vaccine*, *Clinical Infectious Diseases*, and the *Canadian Medical Association Journal*. Her research is supported by operating and infrastructure funding from the Canadian Institutes of Health Research, the Public Health Agency of Canada, the Michael

Smith Foundation for Health Research, and the British Columbia Immunization Committee.

Noel T. Brewer, Ph.D., is a professor of health behavior at the Gillings School of Global Public Health and a member of the Lineberger Comprehensive Cancer Center at the University of North Carolina. Dr. Brewer's research explores why people engage in vaccination and other health behaviors that prevent cancer. He has published more than 280 papers on these topics, including behaviors related to human papillomavirus (HPV) vaccination, tobacco warnings, and screening tests. He was recognized by Clarivate as among the top 0.1 percent most cited researchers in the world from 2017 to 2019. The Announcement Approach Training developed by Dr. Brewer and colleagues teaches health care providers to communicate more effectively about HPV vaccination and other vaccines for adolescents. More than 1,200 providers in 17 states have received the training. The National Cancer Institute designated it as a Research-Tested Intervention Program, and the U.S. Centers for Disease Control and Prevention (CDC) and the American Academy of Pediatrics now recommend use of presumptive announcements when recommending the HPV vaccine. Free materials are available at hpvIQ.org. A large clinical trial by Dr. Brewer and colleagues found that pictorial warnings for cigarette packs help smokers quit. The findings informed a successful lawsuit by the American Medical Association and seven other organizations to force the U.S. Food and Drug Administration (FDA) to implement the enhanced warnings that had been held up by a previous lawsuit. Implementation of the new warnings is now ongoing. Dr. Brewer was the inaugural chair of the National HPV Vaccination Roundtable. He has advised on vaccination for the World Health Organization, CDC, the President's Cancer Panel under two presidents, and the National Vaccine Advisory Committee. Dr. Brewer co-edited FDA's book *Communicating Risks and Benefits: An Evidence-Based User's Guide*. Media coverage of his research includes *The New York Times*, *The Wall Street Journal*, *The Washington Post*, NPR, and CNN. He is proudest of the coverage by *The Onion*. More than 40 students and 11 postdoctoral researchers have completed their training in his Health Cognition and Behavior Lab. Many of these trainees have moved on to postdocs and faculty positions at leading institutions.

Daniel J. Carucci, M.D., M.Sc., Ph.D., is the global medical director for McCann Health's new Global Health offering, providing strategic and technical support for health communications programs that focus on the needs of women and children in the developing world. He is currently the chair of the Scientific Advisory Committee for the Southern Africa International

Centers of Excellence for Malaria Research (National Institutes of Health [NIH]). He is the co-creator of the Immunity Charm, a simple and inexpensive communications tool that harnesses long-standing traditional beliefs to improve vaccine coverage and compliance among children in the developing world. Dr. Carucci is the former vice president for global health at the United Nations Foundation, and he is the former director of the Grand Challenges in Global Health Initiative at the Foundation for NIH. He has served on the boards of directors for The Global Fund to Fight AIDS, Tuberculosis and Malaria; the Rollback Malaria Partnership; the Jane Goodall Institute; Grand Challenges Canada; and the McLaughlin-Rotman Center for Molecular Medicine. Dr. Carucci served 20 years active duty as a U.S. Navy flight surgeon and researcher, retiring with the rank of Captain. He received his M.D. from the University of Virginia School of Medicine. He also holds an M.Sc. in clinical tropical medicine and a Ph.D. in molecular biology from the London School of Hygiene & Tropical Medicine. Dr. Carucci has published more than 70 peer-reviewed articles and book chapters and has been the recipient of numerous awards and medals for his research, military service, and medical practice.

Stefan Flasche, Ph.D., has a diploma (master's equivalent) in mathematics from the Technische Universität in Berlin, and he earned a Ph.D. in mathematical modeling of infectious diseases at Strathclyde University and Public Health England. Since his Ph.D. he has been fascinated by the complexities and challenges of pneumococcal vaccination, which has been his main focus of work. As of 2018, Dr. Flasche's research in this area is funded through a Sir Henry Dale Wellcome Trust Fellowship. Dr. Flasche has also worked in outbreak response (swine flu and Ebola) and has advised the World Health Organization (WHO) on disease modeling (including dengue and malaria). He currently serves on the WHO Strategic Advisory Group of Experts on Immunization's (SAGE's) working group on pneumococcal conjugate vaccines and on the WHO SAGE working group on dengue vaccines, as well on the Joint Committee on Vaccination and Immunization's pneumococcal subgroup.

Jeffery A. Goad, Pharm.D., M.P.H., is a tenured professor of pharmacy practice and the inaugural chair of the Chapman University School of Pharmacy. He received his Pharm.D. from the University of Southern California (USC) School of Pharmacy and his M.P.H. from the Keck School of Medicine of USC. He completed a residency in pediatric pharmacy practice at Children's Hospital Los Angeles and holds the certificate of knowledge in travel health from the International Society of Travel Medicine. For more than 20 years, Dr. Goad has maintained an active practice in travel health clinics and immunization services. He coordinates and teaches courses

in travel medicine, immunizations, epidemiology, and parasitology. He is currently a national faculty and advisory board member for the American Pharmacists Association's (APhA's) Pharmacy-Based Immunization Training Program and the chair of the APhA Travel Medicine Advanced Competency Training Course. He has presented at more than 300 pharmacy and medical conferences and published more than 70 articles and book chapters. Dr. Goad is the vice president for the National Foundation for Infectious Diseases, the former chair for the International Society of Travel Medicine Pharmacist Professional Group, and the former president for the California Immunization Coalition and the California Pharmacists Association.

Anuradha Gupta, M.B.A., is the deputy chief executive officer of Gavi. Since joining Gavi in 2015, Ms. Gupta has led efforts to put equity and gender at the center of Gavi's programmatic planning and to tailor support to countries within Gavi's strategy. She has also driven efforts to create a new model of country-level Gavi support through the establishment of a Partners' Engagement Framework. At the same time, Ms. Gupta has helped improve country ownership and leadership of Gavi-supported programs besides enhancing accountability for results. Prior to Gavi, Ms. Gupta served as the mission director of the National Health Mission in India, where she ran the largest—and possibly most complex—public health program in the world with an annual budget of \$3.5 billion. A passionate and influential advocate of women, young girls, and children, Ms. Gupta played a leading role in India's efforts to eradicate polio transmission, reduce maternal and child mortality, and revitalize primary health care. Ms. Gupta has contributed to a number of important global health initiatives. She served as a member of the Steering Committee for Child Survival: Call to Action, co-chaired the Stakeholder Group for the London Family Planning Summit 2020, and was a member of the Family Planning 2020 Reference Group. Ms. Gupta served as the co-chair of the Partnership for Maternal, Neonatal, and Child Health and is currently a board member. She also played a role in the shaping of the Global Financing Facility (GFF) and is a member of the GFF Investors' Group. From 2015 to 2018, Ms. Gupta served on the Merck for Mothers Advisory Board. Ms. Gupta holds an M.B.A. from the University of Wollongong in Australia and received executive education from Harvard's Kennedy School of Government, Stanford School of Business, and Maxwell School at Syracuse University. She was included on the list of Top 300 Global Women Leaders in Health in 2015 by the Graduate Institute of International and Development Studies and *The Lancet*.

Peter Hotez, M.D., Ph.D., is an internationally recognized physician–scientist in neglected tropical diseases and vaccine development. He is the dean

of the National School of Tropical Medicine and a professor of pediatrics and molecular virology and microbiology at the Baylor College of Medicine, where he is also the director of the Texas Children's Center for Vaccine Development (CVD) and the Texas Children's Hospital Endowed Chair of Tropical Pediatrics. He is also a university professor at Baylor University, a fellow in disease and poverty at the James A. Baker III Institute for Public Policy, a senior fellow at the Scowcroft Institute of International Affairs at Texas A&M University, a faculty fellow with the Hagler Institute for Advanced Studies at Texas A&M University, and a health policy scholar in the Baylor Center for Medical Ethics and Health Policy. As the head of the Texas Children's CVD, Dr. Hotez leads a team and product development partnership for developing new vaccines for hookworm infection, schistosomiasis, leishmaniasis, Chagas disease, and coronavirus diseases (e.g., severe acute respiratory syndrome, Middle East respiratory syndrome, coronavirus disease 2019)—diseases affecting hundreds of millions of children and adults worldwide—while championing access to vaccines in the United States and globally. In 2006 at the Clinton Global Initiative, he co-founded the Global Network for Neglected Tropical Diseases to provide access to essential medicines for hundreds of millions of people.

Dr. Hotez obtained his undergraduate degree in molecular biophysics from Yale University in 1980 (Phi Beta Kappa), followed by a Ph.D. in biochemistry from The Rockefeller University in 1986, and an M.D. from Weil Cornell Medical College in 1987. He has authored more than 500 original papers and is the author of 4 single-author books, including *Forgotten People, Forgotten Diseases* (ASM Press); *Blue Marble Health: An Innovative Plan to Fight Diseases of the Poor Amid Wealth* (Johns Hopkins University Press); *Vaccines Did Not Cause Rachel's Autism* (Johns Hopkins University Press); and a forthcoming book on vaccine diplomacy in an age of war, political collapse, climate change, and anti-science (Johns Hopkins University Press).

Dr. Hotez served previously as the president of the American Society of Tropical Medicine and Hygiene and he is the founding editor-in-chief of *PLOS Neglected Tropical Diseases*. He is an elected member of the National Academy of Medicine (Public Health Section) and the American Academy of Arts & Sciences (Public Policy Section). In 2011, he was awarded the Abraham Horwitz Award for Excellence in Leadership in Inter-American Health by the Pan American Health Organization of the World Health Organization. In 2014–2016, he served in the Obama administration as U.S. Envoy, focusing on vaccine diplomacy initiatives between the U.S. government and countries in the Middle East and North Africa. In 2018, he was appointed by the U.S. Department of State to serve on the board of governors for the U.S.–Israel Binational Science Foundation, and he is frequently called on to testify before Congress. He has served on infectious disease task forces

for two consecutive Texas governors. For these efforts in 2017 he was named by *FORTUNE Magazine* as one of the 34 most influential people in health care, while in 2018 he received the Sustained Leadership Award from Research!America. In 2019 he received the Ronald McDonald House Charities Award for Medical Excellence. Most recently as both a vaccine scientist and an autism parent, he has led national efforts to defend vaccines and to serve as an ardent champion of vaccines going up against a growing national “anti-vax” threat. In 2019, he received the Award for Leadership in Advocacy for Vaccines from the American Society of Tropical Medicine and Hygiene. Dr. Hotez appears frequently on television (including BBC, CNN, *Fox News*, and MSNBC), radio, and in newspaper interviews (including *The New York Times*, *USA Today*, *The Washington Post*, and *The Wall Street Journal*).

Clarissa Hsu, Ph.D., is an assistant investigator at the Kaiser Permanente Washington Health Research Institute. As a medical anthropologist, she has spent more than 20 years exploring how social and cultural factors shape health and health care. Dr. Hsu’s work spans a wide variety of health-related issues, including clinical transformation and health care design, addressing social determinants of health in clinical settings, patient-centered care, and complementary and integrative medicine. Dr. Hsu has been the principal investigator for a number of qualitative and mixed-method studies, including the evaluation of the Immunity Community intervention, an innovative approach to addressing vaccine hesitancy using concepts drawn from social marketing. She also serves on the steering committee for Vax Northwest.

Catherine Jackson, Ph.D., M.Sc., has more than 15 years of experience in the university sector, undertaking applied health services research and evaluation. She has worked as a public health specialist and held research positions at the Universities of Leeds and York. In addition to managing Valid Research, Dr. Jackson is a visiting senior research fellow in the Department of Health Sciences at the University of York and a consultant for the World Health Organization Regional Office for Europe. She has a Ph.D. in health psychology and an M.Sc. in health promotion and health education. Dr. Jackson has considerable experience in all stages of delivering research and evaluation projects, from securing funding, establishing teams, and collecting and analyzing data through writing up, reporting, and publishing findings. Skilled in conducting quantitative, qualitative, and mixed-method research, she has worked in the United Kingdom and internationally with a focus on public health. Her particular research interests are health literacy and decision making for childhood immunization. She has a track record of conducting research with marginalized communities.

Mohamed F. Jalloh, M.P.H., is a behavioral epidemiologist at the U.S. Centers for Disease Control and Prevention (CDC)-Tanzania. Prior to his current position, Mr. Jalloh served as a behavioral epidemiologist in the Global Immunization Division at CDC, where he designed, implemented, and evaluated interventions to improve global demand and uptake of life-saving vaccines. His immunization work comprises a diverse portfolio of projects, including strengthening of immunization systems in Sierra Leone; responding to an outbreak of diphtheria among displaced Rohingyas in Bangladesh; evaluating RTS,S malaria vaccine implementation in Ghana, Kenya, and Malawi; and assessing the drivers of Ebola vaccine acceptance in the Democratic Republic of the Congo, Sierra Leone, and Uganda. In addition, he led the development and validation of the Vaccination Acceptance and Demand Scale, and represented CDC on the World Health Organization's global working group to standardize global measures of vaccination behaviors. Prior to working in immunization, Mr. Jalloh was an epidemiologist in the Division of Global Health Protection, where he provided technical guidance on CDC's global health security priorities in Liberia and Sierra Leone. In Sierra Leone, he contributed to establishing the Child Health and Mortality Prevention Surveillance study site and supported the evaluation of Sierra Leone's implementation of intermittent preventive treatment of malaria in infants. Before joining CDC, he served as a senior research and an evaluation manager with FOCUS1000, a non-governmental organization in Sierra Leone, where he led mixed-method assessments on reproductive, maternal, newborn, and child health. While there, he managed a team of 10 full-time staff and a roster of data collectors in monitoring and evaluating national public health programs. During the 2014–2016 Ebola outbreak response in West Africa, Mr. Jalloh led five national surveys to measure changes in the public's Ebola-related knowledge and behaviors in Guinea and Sierra Leone. In this same period, he also managed a digital reporting system for community-based Ebola surveillance used by 2,000 community reporters. Mr. Jalloh was scheduled to defend his Ph.D. in September 2020 at Karolinska Institutet, where his doctoral research has focused on Ebola behavioral surveillance. He obtained his M.P.H. in health behavior from the University of North Carolina at Chapel Hill and completed his B.S. in public health from Rutgers, the State University of New Jersey. Mr. Jalloh has published more than 30 peer-reviewed papers on a range of public health topics.

Momin Abdul Kazi, M.B.B.S., M.P.H., Ph.D.(c), is an assistant professor at the Aga Khan University (AKU) Hospital. He is a physician (M.B.B.S., Dow Medical College, Pakistan), an epidemiologist (M.Sc., Vanderbilt University), and is pursuing his Ph.D. from The University of British Columbia. Dr. Kazi's research focuses on evaluating and implementing digital and

mobile health interventions, using technology as a research tool in studies and public health projects related to vaccine-preventable diseases. Currently Dr. Kazi is involved as an investigator with multiple research studies funded by the National Institutes of Health, the Bill & Melinda Gates Foundation, and Grand Challenges Canada, to name a few. He is also the co-director of the Research Methods and Applications for Digital Health course, offered to graduate students at AKU. His current work and interests include development and evaluation of systems for real-time data visualization, geospatial analysis, development of auto-generated programs to disseminate public health messages through short message service and voice messages, and other digital applications for improving maternal and child health, including vaccination coverage. He has published more than 40 papers with an h-index of 22, and heavily advocates for mobile phone-based interventions for improving coverage of vaccine-preventable diseases in lower- and middle-income countries. He has both published and reviewed for leading journals, including *The Lancet*, *Bulletin of the World Health Organization*, *BMJ*, *BMC*, *Vaccine*, and the *Journal of Medical Internet Research*, with topics primarily focusing on digital health.

Imran Khan, M.Sc., M.B.A., is Wellcome's Head of Public Engagement and works on the connections among science, society, and culture. He leads Wellcome's efforts in involving the public in its mission of improving health through science and research. This includes supporting the public to trust, use, and inform health research, as well as working with scientists to connect with the rest of society. Mr. Khan is also a trustee of the United Kingdom's innovation foundation, Nesta.

Julie Leask, Ph.D., M.P.H., is a professor and a social scientist in the Susan Wakil School of Nursing and Midwifery, Faculty of Medicine and Health, University of Sydney. Her research focuses on risk communication, responding to vaccine hesitancy and refusal, and strengthening vaccination programs and policy. She has 137 publications in the field. Dr. Leask is a visiting professorial fellow at the National Centre for Immunisation Research and Surveillance. She is the chair of the World Health Organization (WHO) Working Group on Measuring Behavioural and Social Drivers of Vaccination, and she sits on the WHO Immunization and Vaccines-related Implementation Research advisory committee. Dr. Leask is also a member of the Southeast Asia Regional Immunization Technical Advisory Group. She was named overall winner of the Australian Financial Review 100 Women of Influence in 2019.

Louise Letley, R.N., M.Sc., qualified as a nurse in Northern Ireland in 1987. She has extensive primary care clinical research experience. This included

almost 15 years of working at a national level for the Medical Research Council's General Practice Research Framework, where she worked on a number of large public health studies and obtained her M.Sc. from Queen Mary University of London in 2002. Following this she worked at both the national and local level of the newly developed National Institute for Health Research Primary Care Research Network before moving to the National Immunisation Team at Public Health England in 2013. Initially, the main responsibility of the role was to coordinate the evaluation and help support the sites piloting the implementation of the childhood flu program. Since the successful national rollout of the program, Ms. Letley has worked on a number of research projects within the department, including the infant and teenager attitudinal surveys. She was also part of the team working in collaboration with the World Health Organization to deliver the Tailoring Immunization Programmes within the Charedi community in northeast London.

Ethan Lindenberger is a 19-year-old high school graduate from Norwalk High School in Norwalk, Ohio. Mr. Lindenberger has a part-time job, has an internship, and is going to college in the fall. However, in early February 2019, he began to find media attention after pursuing vaccines against the approval of his mother. This became a national story, even leading him to testify in front of the U.S. Senate Committee on Health, Education, Labor, and Pensions about his experiences. Since then, Mr. Lindenberger has continued to take part in advocating for science. He has appeared on most major news networks, including Fox, GMA, CNN, MSNBC, and more. He believes that each individual has a role in ending misinformation, and he has spoken to the importance of scientific truth while also maintaining respect for those that have fallen victim to misinformation.

Ann Lindstrand, Ph.D., M.P.H., is a pediatrician and a public health specialist with an M.P.H. from the Harvard T.H. Chan School of Public Health and a Ph.D. in pneumococcal vaccine epidemiology from the Karolinska Institute in Sweden. She has 30 years of experience in global health, research, lecturing, and program implementation, working mainly in Angola, French Guyana, India, Mozambique, and Uganda. Her main focus of interest is vaccinology, maternal and child health, and humanitarian work. She has worked for Médecins Sans Frontières (MSF), Doctors Without Borders, in the field and served as the president of the MSF board in Sweden for many years. She has worked as the Expanded Programme on Immunization (EPI) Coordinator in the Department of Immunization and Biologicals at the World Health Organization (WHO) since September 2018. Before WHO she was the EPI manager for the national immunization program in Sweden for 5 years.

Nicole Lurie, M.D., M.S.P.H., is currently the strategic advisor to the chief executive officer of the Coalition for Epidemic Preparedness Initiatives. She is also a senior lecturer at Harvard Medical School, a member of the research faculty at Massachusetts General Hospital, and a professor of medicine at The George Washington University School of Medicine & Health Sciences. She served an 8-year term as the assistant secretary for preparedness and response at the U.S. Department of Health and Human Services (HHS). In that role she led the HHS response to numerous public health emergencies, ranging from infectious disease to natural and human-made disasters and is responsible for many innovations in emergency preparedness and response. She also chaired the Public Health Emergency Medical Countermeasures Enterprise, a government-wide organization ultimately responsible for the development of medical countermeasures, including vaccines against pandemics and emerging threats.

Prior to federal service, Dr. Lurie was the Paul O'Neill Professor of Policy Analysis at RAND, where she started and led the public health preparedness program and RAND's Center for Population Health and Health Disparities. She has also had leadership roles in academia as a professor of medicine and public health at the University of Minnesota; as the medical advisor to the commissioner of the Minnesota Department of Health; and as the principal deputy assistant secretary for health at HHS. Dr. Lurie received her B.A. and M.D. from the University of Pennsylvania and completed her residency and public health training at the University of California, Los Angeles. Her research has focused on access to and quality of care, health system redesign, equity, mental health, public health, and preparedness. She is the recipient of numerous awards and is a member of the National Academy of Medicine. She continues to practice clinical medicine in a community clinic in Washington, DC.

Michelle Mello, J.D., Ph.D., is a professor of law at Stanford Law School and a professor of medicine in the Center for Health Policy/Primary Care and Outcomes Research in the Department of Medicine at the Stanford University School of Medicine. She conducts empirical research into issues at the intersection of law, ethics, and health policy. She is the author of more than 200 articles and book chapters on medical liability, public health law, pharmaceuticals and vaccines, biomedical research ethics and governance, health information privacy, and other topics. The recipient of a number of awards for her research, Dr. Mello was elected to the National Academy of Medicine at the age of 40. From 2000 to 2014, she was a professor at the Harvard T.H. Chan School of Public Health, where she directed the school's program in law and public health. Dr. Mello teaches courses in torts and public health law. She holds a J.D. from Yale Law School, a Ph.D. in health policy and administration from the University of North Carolina at Chapel

Hill, an M.Phil. from Oxford University, where she was a Marshall Scholar, and a B.A. from Stanford University.

Monika Naus, M.D., is the medical director of the Communicable Diseases and Immunization Service, and she is the head of Vaccine Preventable Diseases and Immunization Programs at the British Columbia Centre for Disease Control (BCCDC). She is also a professor at the School of Population and Public Health at The University of British Columbia. Dr. Naus obtained her medical training at the University of Alberta and her training in public health and preventive medicine at the University of Toronto. She then served as a federal field epidemiologist with the Laboratory Centre for Disease Control while still in her residency, and subsequently her career focus has been in communicable disease prevention and control. Before joining BCCDC in July 2001, she was the provincial epidemiologist and physician manager of the Disease Control Service in Ontario from 1997 to 2001, and a senior medical consultant in vaccine-preventable diseases and tuberculosis control for the Ontario Ministry of Health and Long-Term Care from 1990 to 1997. She has been active in immunization at the national level, including on the Canadian National Advisory Committee on Immunization (NACI), which she chaired from 2003 to 2007 after being a member for 8 years, and she is a member of several NACI expert groups and liaison representative as the co-chair of the Canadian Immunization Committee. She is a member of the Canadian Immunization Registries and Coverage Network, a co-chair of the Automated Identification of Vaccine Products Working Group, and a member of the Canadian Immunization Research Network, and she is involved in other national and provincial committees. She is a fellow of the Royal College of Physicians of Canada and the American College of Preventive Medicine.

Sean O'Leary, M.D., M.P.H., is a professor of pediatrics at the University of Colorado School of Medicine, a pediatric infectious diseases specialist, an investigator at the Adult and Child Consortium for Outcomes Research and Delivery Science, and the director of the Colorado Children's Outcomes Network, Colorado's pediatric practice-based research network. After completing college at Brown University and medical school at The University of Texas at Houston, Dr. O'Leary did his pediatric residency in Denver at Children's Hospital/University of Colorado. Following residency, Dr. O'Leary was a partner in a large pediatric practice in Fort Collins, Colorado, for 8 years. He then returned to Denver to pursue an infectious diseases fellowship as well as a Primary Care Research Fellowship. Dr. O'Leary's research focuses on prevention of vaccine-preventable diseases through understanding clinical, attitudinal, and infrastructural barriers to vaccination, and developing and testing interventions to address those

barriers. Dr. O'Leary serves as the liaison to the U.S. Centers for Disease Control and Prevention's Advisory Committee on Immunization Practices for the Pediatric Infectious Diseases Society and is the vice chair of the Committee on Infectious Diseases (the Red Book Committee) of the American Academy of Pediatrics.

Jean-Marc Olivé, M.D., M.P.H., started as a general practitioner and an occupational medicine physician in Paris, then as resident gynecologist and obstetrician at the Ministry of Health in Zambia. Before joining the World Health Organization (WHO), he worked for disaster relief in Zaire and was a resident in preventive medicine at the Maryland State Department. In 1980, he was appointed as Expanded Programme on Immunization (EPI) Medical Epidemiologist for WHO, posted in Sudan, then in Pakistan, and later in Peru. At the Pan American Health Organization, Dr. Olivé became the EPI regional adviser, where he contributed to the successful poliomyelitis eradication and measles elimination in the Americas, both initiatives being part of the effort to further strengthen and institutionalize EPI in the region. In 1994, he moved to WHO headquarters in Geneva as the measles focal point, then served as the acting chief of EPI and finally the special project leader for the Vaccines and Biologicals Department in charge of strengthening immunization services. In 2002, Dr. Olivé was appointed as the WHO Representative in the Philippines and then in Vietnam until his retirement at the end of 2010. Since 2011 he has worked as a consultant supporting the Polio Partnership in priority countries, including measles, rubella, and routine immunization activities. He has been appointed as the chair of several polio technical advisory groups (Horn of Africa, Afghanistan, Pakistan, and Lake Chad) and a member of various WHO vaccine-related technical advisory groups and reviews. He is a member of the Gavi Independent Review Committee.

Saad B. Omer, M.B.B.S., Ph.D., M.P.H., is the inaugural director of the Yale Institute for Global Health and a professor of medicine and epidemiology at the Yale University Schools of Medicine and Public Health. He has conducted studies in Bangladesh, Ethiopia, Guatemala, India, Kenya, Pakistan, South Africa, Uganda, and the United States. Dr. Omer's research portfolio includes clinical trials to estimate efficacy and safety of maternal and infant influenza, pertussis, polio, measles, and pneumococcal conjugate vaccines and trials to evaluate drug regimens to reduce mother-to-child transmission of HIV. He has published more than 300 papers in peer-reviewed journals and has mentored more than 100 junior faculty, clinical, and research postdoctoral fellows and Ph.D. and other graduate students.

Dorit Rubinstein Reiss, Ph.D., is a professor of law at the University of California (UC) Hastings College of the Law. Her research and activities are

increasingly focused on legal issues related to vaccines, including exemption laws and tort liability related to non-vaccination. She has published law review and peer-reviewed articles and blog posts on legal issues related to vaccines. She received an undergraduate degree in law and political science (1999, magna cum laude) from the Faculty of Law at the Hebrew University of Jerusalem. She received her Ph.D. from the jurisprudence and social policy program at UC Berkeley. She is a member of the Parents Advisory Board of Voices for Vaccines, and is also active in vaccine advocacy in other ways.

Patricia A. (Patsy) Stinchfield, R.N., M.S., C.P.N.P., has been a pediatric nurse practitioner for more than 30 years. She is currently specializing in infectious disease, infection prevention, and vaccines at the Children's Hospitals and Clinics of Minnesota. She is also the senior director of infection control and the program director for the Children's Immunization Project, a collaborative effort in Minnesota bringing immunization information to parents, providers, and the community. Ms. Stinchfield is a past voting member and current liaison to the U.S. Centers for Disease Control and Prevention's (CDC's) Advisory Committee on Immunization Practices, representing the National Association of Pediatric Nurse Practitioners. She serves as an associate clinical faculty member at the University of Minnesota School of Nursing and sits on several committees, including the Minnesota Department of Health Immunization Advisory Committee. She is the vice president of the National Foundation for Infectious Diseases. A frequent presenter on immunization topics at local and national conferences, including the CDC National Immunization Conference, she is a graduate of Moorhead State University and the University of Utah School of Nursing.

Litjen (L. J.) Tan, M.S., Ph.D., is the chief strategy officer for the Immunization Action Coalition (IAC). Prior to joining IAC, Dr. Tan was the director of medicine and public health at the American Medical Association (AMA), a position he held since 2008. From 1997 to 2008, he was AMA's director of infectious disease, immunology, and molecular medicine. Dr. Tan was a voting member of the U.S. Department of Health and Human Services' National Vaccine Advisory Committee from 2009 to 2013, where he served on the adult immunization, vaccine safety, and health care worker immunization working groups, and chaired the immunization infrastructure working group. He also served for more than 10 years as AMA's liaison to the U.S. Centers for Disease Control and Prevention's (CDC's) Advisory Committee on Immunization Practices, where he served on the influenza, pneumococcal, zoster, and adult immunization working groups. Dr. Tan co-founded and currently co-chairs the National Adult and Influenza Immunization

Summit. He serves or has served on the steering committees or advisory boards of the 317 Coalition, the Adult Vaccine Access Coalition, the Unity (United for Adolescent Vaccination) Consortium, the National Network for Immunization Information, the National Viral Hepatitis Roundtable, and on the IAC scientific advisory board. Dr. Tan also serves, or has served, on the National Quality Forum's Adult Immunizations Expert Committee, the Pharmacy Quality Alliance's Adult Immunization Working Group, and numerous national and international expert and technical advisory committees, including panels for the Centers for Medicare & Medicaid Services, The Joint Commission, and CDC on issues ranging from vaccine hesitancy to immunization quality measurement development, adult immunizations, and immunization access and delivery. In 2007, he founded the National Immunization Congress and organized its 2007 and 2010 meetings.

Dr. Tan received his M.S. in biology at New York University and earned his Ph.D. in microbiology/immunology from the Northwestern University Feinberg School of Medicine. Dr. Tan is an editor for *Vaccine*, *BMC Infectious Diseases*, *Medscape Infectious Diseases*, a member of the ESCMID Vaccine Study Group and has published more than 50 peer-reviewed articles. During his tenure at AMA, he wrote numerous scientific reports to guide the association's policies on a diverse range of public health topics. A skilled and sought-after speaker, Dr. Tan has been invited to address international, national, and state immunization audiences on issues ranging from vaccine financing to risk management in vaccine safety to emerging infectious diseases.

Dr. Tan has received several awards for his advocacy work including the 2011 CDC National Center for Immunization and Respiratory Diseases Honor Awards: Excellence in Partnering recognition, and most recently he was awarded the American Pharmacists Association's national Friend of Pharmacy Award. As a former part-time faculty member at the Institute for Science Education and Science Communication, Columbia College, Chicago, he received the 2000 Excellence in Teaching Award.

Sander Van Der Linden, Ph.D., is a professor of social psychology and the director of the Cambridge Social Decision-Making Lab in the Department of Psychology at the University of Cambridge. He has won numerous awards for his research on human judgment and decision making, including the Rising Star Award from the Association for Psychological Science, the Sage Young Scholar Award from the Society for Personality and Social Psychology, and the Sir James Cameron Medal for the Public Understanding of Risk from the Royal College of Physicians. He also received the 2020 Frank Prize from the University of Florida for his research on fake news. *Wired* magazine described him as one of 15 Top Thinkers and *Fast Company* referred to him as one of four heroes of digital democracy. His research papers have

received awards from organizations such as the American Psychological Association, the International Association of Applied Psychology, and the Society for the Psychological Study of Social Issues. He is the editor-in-chief of the *Journal of Environmental Psychology* and the co-editor of the recent book *Risk and Uncertainty in a Post-Truth Society* (2019).

K. “Vish” Viswanath, Ph.D., is the Lee Kum Kee Professor of Health Communication in the Department of Social and Behavioral Sciences at the Harvard T.H. Chan School of Public Health and in the McGraw-Patterson Center for Population Sciences at the Dana-Farber Cancer Institute (DFCI). He is also the faculty director of the Health Communication Core of the Dana-Farber/Harvard Cancer Center. Other additional administrative and scientific leadership positions held by Dr. Viswanath include the director of the Center for Translational Communication Science, DFCI/Harvard T.H. Chan School of Public Health; director, Harvard T.H. Chan School of Public Health, India Research Center; and co-director, Lee Kum Sheung Center for Health and Happiness, Harvard T.H. Chan School of Public Health. He is the founding director of the Dana-Farber/Harvard Cancer Center’s Enhancing Communications for Health Outcomes Laboratory.

Dr. Viswanath’s work, drawing from literature in communication science, social epidemiology, and social and health behavior sciences, focuses on translational communication science to influence public health policy and practice. His primary research is in documenting the relationship among communication inequalities, poverty and health disparities, and knowledge translation to address health disparities. He has written more than 250 journal articles and book chapters concerning communication inequalities and health disparities, knowledge translation, public health communication campaigns, e-health and the digital divide, public health preparedness, and the delivery of health communication interventions to underserved populations. He is the co-editor of four books and monographs and the editor of the Social and Behavioral Research section of the 12-volume *International Encyclopedia of Communication* (Blackwell Publishing, 2008).

Dr. Viswanath has served and is continuing to serve on several national committees, including for the U.S. Department of Health and Human Services, the U.S. Centers for Disease Control and Prevention, the National Academy of Sciences, and the National Academy of Medicine. In recognition of his academic and professional achievements, Dr. Viswanath has received several awards, including the Postdoctoral Mentor of the Year Award from DFCI; the Joseph W. Cullen Memorial Award for Excellence in Tobacco Research, American Society for Preventive Oncology; the Dale Brashers Distinguished Mentorship Award, National Communication Association; the Outstanding Health Communication Scholar Award, jointly given out by the International Communication Association and the National Com-

munication Association; the Mayhew Derryberry Award from the American Public Health Association for his contribution to health education research and theory; and the College of Liberal Arts Alumnus of Notable Achievement, University of Minnesota. He delivered the 23rd Annual Aubrey Fisher Lecture at The University of Utah in 2009. He was elected as a fellow of the International Communication Association (2011), the Society for Behavioral Medicine (2008), and the Midwest Association for Public Opinion Research (2006).

Todd Wolynn, M.D., M.M.M., is the chief executive officer of Kids Plus Pediatrics. He received his M.D. from the University of Pittsburgh School of Medicine in Pennsylvania and earned an M.M.M. from Heinz College at Carnegie Mellon University. He led clinical vaccine research at Kids Plus for 14 years, including more than 40 studies as both a sub-investigator and a principal investigator. His areas of focus for the past decade have been vaccine communication, patient/family engagement, and pediatricians as advocates. Dr. Wolynn has served in a variety of roles as a consultant and an advisor on vaccine-related projects in his practice, as well as with professional medical organizations, vaccine manufacturers, and other vaccine-related entities. In addition to his work with Kids Plus, he currently serves as the president of the advisory board of Shots Heard Round the World, a nonprofit organization dedicated to supporting, defending, empowering, and galvanizing vaccine advocates.

